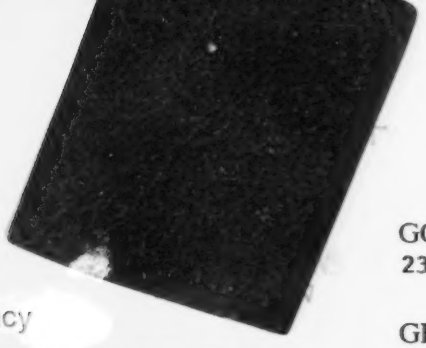

GC

GC(41)/INF/5
23 July 1997

GENERAL Distr.
Original: ENGLISH

International Atomic Energy Agency

# GENERAL CONFERENCE

Forty-first regular session
Item 13 of the provisional agenda
(GC(41)/1)

## MEASURES TO STRENGTHEN INTERNATIONAL CO-OPERATION IN NUCLEAR, RADIATION AND WASTE SAFETY

## THE NUCLEAR SAFETY REVIEW 1997

1. The Agency's Nuclear Safety Review 1997 consists of three parts:

- Part I The Global Nuclear Safety Culture;
- Part II Nuclear, Radiation and Waste Safety in Member States; and
- Part III Topical Safety Issues.

Parts I and III are being reproduced in full in the IAEA Yearbook 1997.

2. Part II, which presents information on significant achievements, developments and issues related to **nuclear, radiation and waste safety** in a range of Member States, consists of material provided to the Secretariat late in 1996 and early in 1997 by Member States and a summary of that material prepared by the Secretariat. Only the summary is being reproduced in the IAEA Yearbook 1997.

3. For the information of the General Conference, Part I of the Nuclear Safety Review 1997 is reproduced in Annex 1 to the present document, the summary of the material provided by Member States for Part II is reproduced in Annex 2 and Part III is reproduced in Annex 3. The material provided by Member States (which has undergone minor editing) is reproduced in the Attachment to the present document.

# NUCLEAR SAFETY REVIEW 1997

## PART I

## THE GLOBAL NUCLEAR SAFETY CULTURE

### The infrastructure

As stated in the *Nuclear Safety Review 1996*, three components characterize the global nuclear safety culture infrastructure: (i) legally binding international agreements; (ii) non-binding common safety standards; and (iii) the application of safety standards. The IAEA has continued to foster the global nuclear safety culture by supporting intergovernmental collaborative efforts; it has facilitated extensive information exchange, promoted the drafting of international legal agreements and the development of common safety standards, and provided for the application of safety standards by organizing a wide variety of expert services.

### Legally binding international agreements

Interdependence in the nuclear field calls for legally binding international agreements, the first component of the global nuclear safety culture infrastructure, and during 1996 Member States - through the IAEA - were active in the development and the implementation of such agreements.

(i) *The development of agreements*

*Liability for nuclear damage*

In 1996 the Standing Committee on Liability for Nuclear Damage held three sessions, during which it resolved most of the outstanding issues regarding both a draft protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage and a draft supplementary funding convention. In particular, the experts agreed on such important issues as liability amounts, the definition of "damage" and related provisions, a supplementary funding structure and phasing-in mechanisms which would allow States to accede to the revised Vienna Convention and the envisaged supplementary funding convention with interim - lower - amounts of liability.

In October 1996, at its sixteenth session, the Standing Committee prepared full texts of the two draft instruments and concluded that, as a substantive package, the two texts reflected what could be achieved in the Committee without further guidance. It was agreed to refer the texts and the substantive package which they reflected to governments for detailed scrutiny. To take into account governments' views thereon, a session of the Standing Committee was scheduled for February 1997 with a view to the adoption of final texts for

submission to the Board of Governors so that it might take a decision regarding the holding of a diplomatic conference later in the year.

*Convention on the safety of radioactive waste management*

During the development of the Convention on Nuclear Safety, the question of the safety of radioactive waste was discussed many times. It was eventually decided to restrict the Convention to matters concerned with the nuclear safety aspects of land based civil nuclear power plants but to go ahead with the development of a convention on the safety of radioactive waste management. In September 1994, the IAEA General Conference invited the Board of Governors and the Director General to commence preparations for such a convention. After a preparatory meeting, the Director General set up an open-ended Group of Legal and Technical Experts to work towards a draft of such a convention. The Group, which has met frequently, has scheduled its seventh meeting - expected to be its final one - for 10-14 March 1997. More than 50 countries and several international organizations have taken part in the Group's discussions.

Like the Convention on Nuclear Safety, on which it is modelled, the convention being developed is an `incentive' convention. It contains a requirement for reporting at meetings of Contracting Parties and relies for its implementation on a peer review process. The convention is intended to apply to all types of radioactive waste and implements the principles set out in the IAEA Safety Fundamentals publication (Safety Series No. 111-F) published in 1995. Also, it includes the provisions of the IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste. Points of difficulty in the development of the convention have included the extent to which it should apply to the safety of spent fuel management, the arrangements by which waste from military and defence activities should be brought within the scope of the convention and provisions regarding discharges of radioactive materials to the environment.

When the Group has completed its work, the draft convention will have to be considered by the Board of Governors and by a diplomatic conference before the final text is opened for signature.

(ii) *The implementation of agreements*

*Convention on Nuclear Safety*

Paragraph 1 of Article 31 ("Entry into Force") of the Convention states that the "Convention shall enter into force on the ninetieth day after the date of deposit with the Depositary of the twenty-second instrument of ratification, acceptance or approval, including the instruments of seventeen States, each having at least one nuclear installation which has achieved criticality in a reactor core." On 26 July 1996, the Director General of the IAEA received the twenty-fifth instrument of ratification, acceptance or approval, that instrument being the seventeenth from a State having at least one nuclear installation which has achieved criticality in a reactor core. Accordingly, the Convention entered into force on 24 October 1996.

The Convention requires countries to fulfil a number of obligations relating to the regulation, management and operation of nuclear power plants. There is a fundamental obligation to establish and maintain an effective legislative and regulatory framework. A central provision calls for the review, at meetings held at least once every three years, of national reports demonstrating fulfilment of the various obligations. The reports will undergo expert examination, with open discussion of identified safety issues and potential problems.

Implementation of the Convention will involve a peer review process, the scope and modalities of which have to be decided on by the Contracting Parties. At a preparatory meeting of the Contracting Parties held on 21-25 April 1997, the Contracting Parties reviewed draft guidelines regarding the peer review process, draft guidelines regarding national reports and draft rules of procedure and financial rules prepared at three informal meetings convened by the IAEA (the last one in June 1996).

**CONVENTION ON NUCLEAR SAFETY**

| | |
|---|---|
| **Opened for signature:** | **20 September 1994** |
| **Entered into force:** 90th day after the date of deposit of the 22nd instrument of ratification, acceptance or approval, including the instruments of 17 States each having at least one nuclear installation which has achieved criticality in a reactor core. | **24 October 1996** |
| **Status as of 24 January 1997:** 65 signatories; 34 parties, 23 of them having at least one nuclear installation which has achieved criticality in a reactor core. | |
| **Preparatory meeting of the Contracting Parties:** Not later than six months after entry into force. | **21-25 April 1997** |
| **First review meeting:** Within 30 months of entry into force - i.e. not later than 24 April 1999. | |

*Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*

No official notifications of nuclear accidents or requests for assistance were received by the IAEA in 1996. However, the enquiries received from the contact points of a number of States about reports of incidents in other States were responded to by the IAEA's Emergency Response Unit (ERU). For example, the ERU followed up reports about fires in the neighbourhood of the Chernobyl nuclear power plant (NPP) and the information obtained was conveyed to the IAEA's General Conference, which was meeting in Vienna at the time.

In connection with the unplanned re-entry of the Russian Federation's Mars 96 satellite, which was carrying about 270 g of plutonium-238, the IAEA made offers of help under the Assistance Convention to both Chile and Bolivia, but no request for any specific form of help was made. This satellite incident highlighted discrepancies between, on one hand, the Early Notification Convention and the Assistance Convention and, on the other, various international legal instruments concerned with outer space as regards reporting and the provision of assistance in the event of such incidents, but it is hoped that these discrepancies will be resolved in the course of 1997.

Although each of the conventions requires that each State party make known to the IAEA a single contact point for the purposes of implementation of that convention, at the start of 1996 the average number of contact points per State party was two. During the year, the total number of contact points was reduced from 270 to 245, and States parties are being encouraged to assist in further reducing that number.

During 1996, the IAEA's Emergency Response System was reorganized and its operating procedures revised. Also, new standardized notification and request procedures for Member States were introduced. Activities continued to be co-ordinated with those of other United Nations bodies that would have a role to play in the event of a nuclear accident or radiological emergency.

**Non-binding common safety standards**

Internationally recognized non-binding safety standards, recommendatory in nature, have become a principal means of achieving harmonized safety approaches in the nuclear power field and in industrial, medical and various other applications of radiation and radioactive materials. Nuclear and radiation safety remains, however, a national responsibility.

As regards IAEA safety standards, the latest edition of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the Basic Safety Standards) and the latest edition of the Regulations for the Safe Transport of Radioactive Material (the Transport Regulations) were published.

The new Transport Regulations contain significant changes, including a requirement for more robust packages for the transport by aircraft of some material and special provisions for the transport of uranium hexafluoride. Although they have been subjected to some criticism in certain quarters, the new Transport Regulations represent a consensus arrived at by experts in the transport of hazardous materials.

Advisory material for the application of the new Transport Regulations are being prepared. Difficulties in applying the new Transport Regulations are being documented and will be taken into account in the next revision exercise.

The set of advisory bodies created to assist the IAEA in preparing and reviewing safety-related documents and made up of senior officials from regulatory organizations - the Advisory Commission on Safety Standards (ACSS) and the Nuclear Safety Standards Advisory Committee (NUSSAC), the Radiation Safety Standards Advisory Committee (RASSAC), the Waste Safety Standards Advisory Committee (WASSAC) and the Transport Safety Standards Advisory Committee (TRANSSAC) - commenced work in 1996.

*IAEA safety publications*

In 1996 it was decided that the IAEA's Safety Series would be replaced by two new series of safety-related publications, the Safety Standards Series and the Safety Reports Series, the purpose being to separate those IAEA safety publications which are intended to spell out objectives, concepts and principles, to serve as a basis for national regulations or to indicate how various safety requirements may be met from those which are issued for informational purposes.

The publications issued in the Safety Standards Series will be issued pursuant to Article III of the IAEA's Statute, which states that the IAEA is authorized "*To establish or adopt ..... standards of safety for protection of health and minimization of danger to life .....*". They will comprise Safety Fundamentals, Safety Requirements and Safety Guides and will cover nuclear safety, radiation safety, waste safety and transport safety. The Safety Fundamentals documents will spell out objectives, concepts and principles; the Safety Requirements will state what must be done in order to ensure safety in different areas of activity and can serve as a non-binding basis for Member States' national regulations; and the Safety Guides will supplement the Safety Requirements documents by recommending ways of meeting requirements.

The publications issued in the Safety Reports Series will be issued for the purpose of providing information on methods that can be used in order to ensure safety.

**Peer reviews and advisory services in safety matters**

The provision of peer review and advisory services by international experts and of training - the third and final component of the global nuclear safety culture infrastructure - has proved to be an important mechanism for drawing on the nuclear, radiation and waste safety experience which is available around the world. During the past decade, the IAEA has drawn on this experience in providing widely used services. Also, a number of organizations such as the World Association of Nuclear Operators (WANO) have established expert review mechanisms that are being used increasingly. A major purpose of the review and advisory services which are being provided is to assist national authorities and organizations in applying safety standards.

*OSART, ASSET and IPERS services*

Among the IAEA services are Operational Safety Review Team (OSART) missions for assessing, at the request of Member States, nuclear power plant management practices and operational programmes and the performance of plant equipment and personnel (rather than the adequacy of plant designs). The teams do not assess overall plant safety or compare the safety performance of different plants, but provide plant operators with recommendations and suggestions for strengthening safety and identify good practices that might be usefully followed by others.

In 1996, within the framework of the IAEA's Assessment of Safety Significant Events Team (ASSET) service, which is used in the investigation of operational incidents and of long-term operating histories, seven training courses were held at nuclear power plants in order to familiarize plant staff with the ASSET guidance for self-assessment.

International Peer Review Services (IPERS) for Probabilistic Safety Assessment (PSA) have been conducted since 1988 at the request of Member States. The reviews focus on ensuring the reliability of Level 1 PSAs carried out by the Member States for the identification of safety issues and in support of backfitting and other plant imporvement decisions. Two such reviews were conducted at the request of the Czech Republic and Argentina in 1996.

*Upgrading of radiation and waste safety infrastructures*

An interregional technical co-operation project (Model Project) was launched in 1994 for the purpose of helping a number of selected Member States with inadequate radiation and waste safety infrastructures to enhance and strengthen them so that they complied with standards established by the IAEA for protection against ionizing radiation and for the safety of radiation sources. The Model Project was launched following the recognition that, despite RAPAT (Radiation Protection Advisory Team) missions (to 64 Member States), which had increased awareness of radiation safety issues and led to an enhancement of radiation safety, a few Member States still did not have any radiation safety infrastructures and a substantial number had infrastructures which were still inadequate for their level of usage of ionizing radiation.

One of the first actions taken under the Model Project was to define what constitutes adequate radiation and waste safety infrastructures for different levels of usage of ionizing radiation and radioactive materials - for the simple industrial and medical applications that exist in every country and for the nuclear fuel cycle activities that exist in relatively few countries. The resulting document sets out the basic elements of radiation protection infrastructures, ranging from the legislative framework and regulatory structure through the user compliance requirements to the equipment and procedures needed.

It was originally envisaged that some five or six countries would benefit each year from the Model Project. However, information subsequently gathered for Country Safety Profiles indicated that over 50 countries (including some new Member States) needed to improve their radiation and waste safety infrastructures. At present, 53 countries are covered by the Model Project.

For all these countries, assessments have been made to identify infrastructural weaknesses (for example, inadequate information - or even a complete lack of information - on the radiation sources in the country, radiation and waste safety regulations, personnel dosimetry services, and calibration and state of repair of equipment) and draft work plans prepared in the light of the assessments. In many cases, after consultations with national counterparts the IAEA has submitted the draft action plans to the appropriate authorities for approval, and in the majority of cases the draft action plans have already been approved and implementation has commenced.

*Waste safety review services*

Peer reviews of radioactive waste management facilities in Member States, of national strategies for radioactive waste management and of associated research programmes are organized by the IAEA at the request of Members States, which thereby benefit from the experience of internationally recognized experts in improving national arrangements for the management of radioactive waste. The result is enhanced credibility and greater public acceptance of their radioactive waste management plans.

In 1996, a team of experts co-ordinated by the IAEA conducted a review of the French programme for the management of short lived radioactive waste. The long term safety of France's new disposal facility Centre de l'Aube was one of the main issues in this review. The IAEA and the Nuclear Energy Agency of the OECD are organizing a peer review of the performance assessment produced by the US Department of Energy for the licensing of its Waste Isolation Pilot Plant (WIPP), which is to be used for the final disposal of the transuranic waste generated in the production of nuclear weapons and in other defence related activities.

*Spent fuel storage at Vinča*

A 6.5 MW(th) heavy water cooled and moderated research reactor installed in 1959 at the Institute of Nuclear Sciences in Vinča, near Belgrade, has been shut down since 1984. The spent fuel storage pool contains several thousand fuel slugs in sealed aluminium drums and in stainless steel tubes. Lack of attention to water treatment has given rise to corrosion, and in 1995 mounting concern about the condition of the pool prompted the Institute to request assistance from the IAEA.

In November 1995, an IAEA team found the water in the pool and in one of the stainless steel tubes to be highly corrosive, and more recently several water samples taken from some of the stainless steel tubes proved to be highly radioactive. Since the same

demineralized water was used in filling the sealed aluminium drums, it is assumed that corrosion has been taking place in them and that, if the seals are intact, the buildup of corrosion gases could cause one or more drums to rupture.

A team of experts from France, the Russian Federation and the USA, together with three IAEA staff members, visited Vinča during October 1996 and reviewed the situation in detail. The mission resulted in a better understanding of the condition of the spent fuel storage pool and a clearer perception of the required remedial actions. In particular, venting of the drums is necessary in order to relieve any possible over-pressure.

The IAEA is helping the Institute to draw up a venting plan and to purify the pool water.

*Contact Expert Group*

Following recommendations made in May 1995 at a seminar on international co-operation in nuclear waste management in the Russian Federation held in Vienna, a Contact Expert Group (CEG) has been established to assist with bilateral and multilateral co-operative efforts to resolve radioactive waste management issues in the Russian Federation. The IAEA is acting as secretariat for the CEG.

The CEG currently consists of eleven `full' members - Belgium, France, Finland, Germany, Norway, the Russian Federation, Sweden, the United Kingdom, the USA, the European Union and the International Institute for Applied Systems Analysis (IIASA) - and two observers - the Nordic Environmental Finance Corporation and the International Science and Technology Center. At its first two meetings, held in Vienna in March and September 1996, the CEG approved action plans for 1996-1997 and reviewed the progress made in establishing a database of about 100 co-operative projects under way, planned or suggested.

*Radiological study of Mururoa and Fangataufa Atolls*

At the request of the French Government, the IAEA is carrying out a comprehensive study of both the present and the future radiological situation at the Mururoa and Fangataufa Atolls. The study is being financed primarily by France, contributions in kind being made by other Member States. An International Advisory Committee (IAC) of independent, highly qualified experts from Member States and ex officio experts selected by relevant intergovernmental organizations has been convened by the Director General to provide scientific guidance to the IAEA on all matters related to the conduct of the study.

In order to assess the present radiological situation, use will be made of the large amount of data available in the literature (including data collected by the French authorities over the years) on the levels of radioactive material in the local environment. These data must be validated, and to this end an independent sampling and surveillance campaign was carried out at the Atolls during July 1996. Eleven laboratories in nine countries are participating in the analysis of the terrestrial samples collected; the marine samples are being analysed by six laboratories in six countries plus the IAEA Marine Environment Laboratory

in Monaco and the Seibersdorf Laboratories. The results are expected to be available in March or April 1997. The assessment of individual radiation doses will be based on the validated environmental data.

The study includes an assessment of the longer term impact of the radioactive material remaining in the underground test cavities and in other locations. The assessment has started with an estimation of the residual activity in the cavities and of the distribution of radionuclides between the lava, rubble, walls and gas pockets within each cavity. The results will form the input to models of the movement of the residual material from the cavities through the geosphere (fractured by the test explosions) into the sea and thence to local, regional and far-field populations. Finally, the doses will be assessed in the same way as for the present radiological situation.

The study is progressing on schedule for completion early in 1998.

*Accidents at irradiation facilities - learning to observe the standards*

Accidents occur in all industries, despite the increasing emphasis on occupational health and safety in recent years. In industries which involve particularly hazardous operations, rigorous safety standards must therefore be observed. This applies to the gamma and electron irradiation facilities used in - for example - sterilizing medical supplies, preserving foodstuffs, eradicating insect pests and modifying chemical polymers, as the radiation fields within them during exposure are extremely high, capable of causing serious and sometimes fatal injuries for exposure times of minutes or even seconds. Regrettably, several accidents with such facilities have occurred over the past forty years, resulting in a number of deaths and in the amputation of irradiated limbs. All of these accidents were avoidable and should have been prevented.

The IAEA has analysed the most serious accidents and drawn attention to the lessons that it is hoped will be learned from them. The analysis points to three sets of contributory factors: first, facility design flaws, failure to maintain equipment as foreseen in the facility design and modifications to the facility not anticipated in the design; second, the compromising of safety systems by component failures or by actions taken by the operating organization, management or personnel in order to disable or bypass them; third, inappropriate actions resulting from misinformation, lack of knowledge or the ignoring of conflicting information. Some of these contributory factors constituted long standing practices which should have been detected and corrected by management.

Among the lessons learned were the following:

- Diverse and redundant safety systems and multiple levels of safety are necessary so that the failure of a single component does not result in a hazardous situation:

- Facility design and operation should be reviewed periodically in order to identify factors likely to undermine safety (for example, procedural changes introduced by workers; changes in product shape, size or weight or in packing material; skimped repairs; short-cut solutions to problems);

- Employees should undergo regular retraining;

- Management should ensure the continuing quality of safety systems and prevent operators from bypassing them;

- Personnel skilled in performing routine operations should be trained to recognize and respond appropriately to safety system faults and failures.

In the light of the analysis, the IAEA also made some general observations: first, organizations funding the provision of irradiation facilities should ensure that there is adequate regulatory control in the prospective recipient countries and make funding conditional on a demonstration that appropriate standards will be adhered to; second, operating organizations have a responsibility to demonstrate to the regulatory authority their adherence to the relevant national and international standards of safety; and third, designers, manufacturers, suppliers and installers of irradiation facilities have a continuing obligation to provide adequate information on operating and maintenance procedures.

*Accidental overexposures of radiotherapy patients*

During the second half of 1996, more than a hundred radiotherapy patients in Costa Rica experienced accidental overexposures sufficient to cause severe health effects in some cases (depending on radiation doses received and organs affected). The matter is currently the subject of judicial investigation. Technical details have not been made available, but unofficial reports indicate that the overexposures were caused by human error. The IAEA has received from Costa Rica a request for training and expert services in the radiotherapy field, but not for assistance in clarifying the circumstances of the incident.

*The International Arctic Seas Assessment Project*

The International Arctic Seas Assessment Project - a three-year study of the radiological impact of radioactive wastes dumped in the shallow waters of the Kara and Barents Seas - has been completed and a summary report has been submitted to the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention 1972).

The study, for which some financial support was provided by the USA, involved more than 50 experts from 14 countries and several exploratory visits to the affected area, notably during cruises which were organized by Norwegian and Russian institutions working together and in which personnel from the IAEA Marine Environment Laboratory participated.

The experts: (i) examined the current radiological situation in Arctic waters in assessing evidence of radioactive releases from the dumped wastes; (ii) made predictions of potential future radioactive releases from the dumped wastes; (iii) modelled the environmental transport of the radionuclides which may be released in the future and assessed the associated radiological impact on human life and biota; and (iv) examined the feasibility, costs and benefits of possible remedial measures.

The main conclusion of the study is that the current radiological risks represented by the dumped wastes and the future risks to typical local population groups are small. The projected future risks to a hypothetical group of military personnel patrolling the foreshores of the fjords of Novaya Zemlya in which high level wastes were dumped are considered to be greater - comparable to those associated with natural radiation. Consequently, it is recommended that, if the military controls in Novaya Zemlya are removed, the situation at the fjords be reassessed with a view to estimating the potential exposure of any new groups of individuals and to avoiding inadvertent disturbance of the high level wastes.

A further conclusion of the study is that there is no justification on radiological grounds for instituting a programme of remedial action. However, it is recommended that efforts be made to locate all high level waste objects whose whereabouts are still unknown and that, in order to detect any changes in the condition of the wastes, the establishment of a limited programme of environmental monitoring at the dump sites be considered.

*Study of marine radioactivity at and around radioactive waste dumping sites*

Under an agreement between the Governments of Japan, the Republic of Korea and the Russian Federation, the IAEA Marine Environment Laboratory was invited to participate in joint Japanese-Korean-Russian expeditions to radioactive waste dumping sites in the north-west Pacific Ocean and marginal seas carried out on board a Russian vessel in March/April 1994 and August/September 1995.

Seawater from several depths and seabed sediments were sampled at 14 sites where radioactive waste with a total activity of more than 700 TBq had been dumped and - for the purpose of establishing background levels - at six other locations. In addition, samples were collected in an area of the Sea of Okhotsk, where a strontium-90 source with an activity of 13 PBq destined for a lighthouse had been lost during transport.

After completion of the analyses of the water and sediment samples, representatives of the participating countries and the IAEA Marine Environment Laboratory reviewed the results at a meeting held in Monaco in September 1996. The report on the study is to be issued before the end of 1997.

*Safety of WWER and RBMK reactors*

An important result of the IAEA's activities has been the establishment of an international consensus regarding the major safety issues associated with WWER and RBMK nuclear power plants (NPPs) and the ranking of those issues according to their significance.

In 1996, the IAEA provided guidance on resolving of those issues and organized meetings to develop state-of-the-art reports in the following areas: accident analysis using best estimate methods; the analysis of accidents occurring under shutdown conditions; anticipated transients without scram at WWER NPPs; primary-to-secondary leaks at WWER NPPs; WWER steam generator integrity; WWER-440/213 containment analysis; pressurized thermal shock analysis; qualification of non-destructive testing; three-dimensional computer codes for RBMK core analysis; and RBMK fuel channel integrity.

Member States operating WWER and RBMK reactors requested the IAEA to review proposed safety improvement programmes against the internationally agreed lists of safety issues, and the IAEA reviewed the safety improvement programmes for the Paks NPP (Hungary), the Temelin NPP (Czech Republic) and the Rovno, Khmelnitsky and South Ukraine NPPs (Ukraine). It was found that these programmes generally addressed the safety deficiencies previously identified. However, at all of these nuclear power plants a great deal of design and safety analysis work must still be done before the modifications are made.

The IAEA provided, on a plant specific basis, safety services and experts for the purpose of - inter alia - assessing seismic safety and operational safety, reviewing safety significant events, probabilistic safety assessments and application of the leak-before-break concept, and assessing the strength of WWER-440/213 bubbler condensers.

Despite the nuclear safety improvements which have taken place in eastern Europe and countries of the former Soviet Union in recent years, the need of international assistance remains, particularly in connection with the early generation of WWER and RBMK reactors. It is recognized that these reactors must undergo further safety improvements owing to both design and operational deficiencies.

In the 1997-1998 period, the IAEA's activities relating to WWER and RBMK safety will be implemented under the regular budget, with support from the technical co-operation programme and from extrabudgetary contributions. A regional technical co-operation project on Strengthening nuclear safety regulatory bodies, through which regulatory bodies are being helped to improve their licensing procedures, to elaborate nuclear safety standards and to train their staff, is continuing during 1997. Two new regional projects have been approved for 1997-1998, one designed to provide support with nuclear power plant safety analyses and the other to strengthen nuclear power plant infrastructures for the management of operational safety.

The extrabudgetary programme on the safety of WWER and RBMK reactors will be completed by the end of 1998. The outstanding issues will be integrated into the IAEA regular programme and technical co-operation projects.

**Moscow Nuclear Safety and Security Summit, 19-20 April 1996**

The final declaration of the Moscow Nuclear Safety and Security Summit includes a commitment to give absolute priority to safety in the use of nuclear energy. Co-operation between participating countries to the Summit is a key to the use of nuclear energy all over

the world and to its conduct consistent with fundamental principles of nuclear safety. In addition, commitments are made to openness and transparency in order to obtain public trust and to an effective nuclear safety culture. Sustainable nuclear safety requires a supportive economic and legal environment whereby both operators and national regulatory bodies can fully assume their independent responsibilities. Peer reviews are encouraged to give greater international transparency; this should lead to existing reactors which do not meet current safety requirements being brought to an acceptable level of safety or ceasing operation.

National efforts have been made in the countries of central and eastern Europe and the newly independent states of the former USSR to improve nuclear safety levels, often in co-operation with multilateral and bilateral programmes. In this regard, these important efforts to upgrade reactor safety and improve safety culture are acknowledged, but it is noted that further substantial progress is required.

**Sharing of information**

The sharing of safety information is an important element of a global nuclear safety culture, and major international conferences and meetings are a productive forum for exchanges of views and experience.

In October 1996, a symposium entitled *"Reviewing the safety of existing nuclear power plants"* was held in Vienna by the IAEA in co-operation with the Nuclear Energy Agency of the OECD as a follow-up to the 1991 conference on the *"Safety of Nuclear Power: Strategy for the Future"*. At the symposium, the progress made in implementing the conference's recommendations were reviewed and the importance of making information on effective safety review and safety experience feedback methods, practices and criteria available to all involved in maintaining and improving the safety of nuclear power plants was emphasized. Also, it was shown that there is general agreement about the key elements constituting an acceptable level of safety, but there were differences regarding the use of both deterministic and probabilistic criteria in safety reviews. In addition, the symposium indicated that in implementing the Convention on Nuclear Safety it would be useful to draw on past and ongoing safety reviews and experience feedback programmes.

A major conference on the consequences of the Chernobyl accident - jointly sponsored by the European Commission, the World Health Organization and the IAEA - was held in April 1996 in Vienna. The proceedings of the conference have been published by the IAEA.

Several meetings of nuclear power regulators were held in 1996. For example, the latest annual IAEA-organized Senior Regulators' Meeting was held during the 1996 session of the IAEA's General Conference (the papers presented form the basis for a number of articles in Part III of this Overview) and representatives of the regulatory authorities of Member States operating CANDU reactors convened at the IAEA's Headquarters for their third annual meeting.

The regulatory authorities of countries operating WWER reactors met in June 1996 in the Czech Republic as the Co-operation Forum for WWER Regulators. The Forum was established in 1993 to foster the enhancement of nuclear safety and radiation protection through the utilization of collective experience and through information exchange and to co-ordinate the efforts of national nuclear safety authorities in studying safety problems and improving regulatory policy and practices. The current members of the Forum are Armenia, Bulgaria, the Czech Republic, Finland, Hungary, the Russian Federation, Slovakia and Ukraine. The IAEA, the Nuclear Energy Agency of OECD, Germany and the USA may participate as observers.

The Forum conducts its work through ad hoc working groups on specific safety topics, the results being reviewed at annual meetings. Working groups on seismic upgrading and periodic reviews of WWER reactors have recently completed their tasks. Other topics currently being considered by working groups are: country reports on nuclear safety (preparation for reporting in connection with the Convention on Nuclear Safety); in-service inspections; the licensing of dry spent fuel storage facilities; and reactor pressure vessel embrittlement.

**Looking ahead**

Review and advisory services can become purely routine, and efforts to keep them relevant to a large and mature nuclear industry are necessary. Some operating organizations resist lengthy and what they consider potentially disruptive reviews; international expert evaluations of self-assessments carried out by national authorities and by operating organizations can be effective and less burdensome. It is planned to increase the scope of the ASSET service to include evaluations of nuclear power plant safety performance self-assessments based on records of reportable events, safety system unavailability and plant operation, maintenance, testing, inspection, replacement and modification. In this connection, guidance is being developed for reviews of operational safety performance using available tools and methods for root cause analysis and determining the safety significance of events and trends. Regional technical co-operation projects designed to help Member States in Europe and the region of East Asia and the Pacific to benefit from the new approach have been approved for 1997-1998.

During 1997-1998, the IAEA will - as an extrabudgetary activity - organize meetings on the generic safety issues associated with WWER-1000 reactors and first- and second-generation RBMK reactors. Special consideration will be given to ensuring that subsequent activities concerned with the safety of WWER and RBMK reactors are conducted under the IAEA's Regular Budget programme or under other international programmes.

Brazil, China, Lithuania, Romania, Slovenia, Slovakia and South Africa - Member States which are not members of OECD - are providing information through the IAEA to the Information System on Occupational Exposure (ISOE) established by the Nuclear Energy Agency of the OECD. Armenia, the Russian Federation and Ukraine will be invited in 1997 also to provide information to the ISOE through the IAEA.

In 1997-1998 the IAEA will, through two technical co-operation projects, initiate the creation of health physics groups at WWER and RBMK nuclear power plants and support training in the application of the ALARA ("as low as reasonably achievable") concept. Closely related to these two projects is a co-ordinated research programme (1996-1999) entitled "Intercomparison for Individual Monitoring of External Exposure from Photon Radiation", which is focusing on IAEA Member States in eastern Europe and is supported by the European Commission.

In the field of radiation and waste safety, it is expected that the IAEA, which has been involved in several projects dealing with residues from past activities (for example, an assessment of the situation at Bikini Atoll), will be required to increase its efforts regarding three interrelated topics: chronic exposure situations, the restoration of contaminated areas and the decommissioning of obsolete facilities.

Most radiation accidents leading to injury and fatality continue to occur with radiation sources used outside the nuclear industry. The IAEA strives to improve the prevention of such accidents both by critically reviewing accidents that do occur, in order to disseminate information on case studies and lessons learned from them, and by promoting the implementation of effective regulatory infrastructures for the control of sources; the latter is a major focus for assistance to developing Member States in the immediate future.

In the field of nuclear installation safety, it is expected that the IAEA's activities in South-East Asia will need to be intensified. Also, additional work is likely to arise as ageing research reactors are either upgraded, moth-balled or decommissioned.

The process established for the development of safety standards is expected to ensure the optimal applicability of the standards for the IAEA safety services and to provide a frame of reference for the implementation of conventions.

In planning its future nuclear safety programmes, the IAEA must ensure that they are technically sound and respond to the needs of Member States and that appropriate priorities are set. As part of its planning and evaluation process, the IAEA will continue to subject its nuclear safety programmes to very comprehensive reviews by experts nominated by Member States. Following such a review in July 1995, there was a further one in January 1997, with representatives of 15 Member States examining the results of past programmes and providing guidance for the future.

# NUCLEAR SAFETY REVIEW 1997

## PART II

## NUCLEAR, RADIATION AND WASTE SAFETY IN MEMBER STATES

Information on significant achievements, developments and issues related to nuclear, radiation and waste safety was requested from Member States in November 1996. This review summarizes information provided by 26 Member States, namely Belarus, Belgium, Bulgaria, China, Colombia, the Czech Republic, Egypt, Finland, Germany, Hungary, India, Ireland, Malaysia, Mexico, the Netherlands, Pakistan, the Philippines, Poland, Slovakia, Slovenia, Spain, Sweden, Tunisia, Turkey, the United Kingdom and the United States of America.

### SAFETY LEGISLATION

Several Member States reported progress on the development of fundamental national legislation governing the use of atomic energy and radioactive materials, to bring it into line with current international standards:

- Two draft laws are being prepared in Belarus to govern (i) the use of atomic energy and radiation protection, and (ii) radiation protection of the population;

- In Colombia, a Nuclear Energy Law has been drafted (with technical assistance from the IAEA), and is being reviewed prior to being presented to the Ministry of Mines and Energy;

- The Czech Parliament approved a new Law on the Peaceful Utilization of Nuclear Energy and Ionizing Radiation. This law provides a framework for regulation by defining the powers and responsibilities of the State Office for Nuclear Safety, the nuclear safety and radiation protection principles to be applied, and the responsibilities of licensees. The law also provides for the creation of a Radioactive Waste Repositories Agency, and reflects the obligations of the Czech Republic resulting from the Vienna Convention on Civil Liability for Nuclear Damage;

- The Hungarian Government presented a new Atomic Energy Act to Parliament for discussion. The Act takes account of the 1990 Recommendations of ICRP and the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources;

- A Law on Peaceful Uses of Nuclear Energy has been submitted for approval in Slovakia. This Law aims to update and improve the legal basis for nuclear safety regulation, and to reflect Slovakia's obligations under international agreements.

## CONVENTIONS AND AGREEMENTS

Several Member States reported their ratification of the Convention on Nuclear Safety, and involvement in the development of the Convention on the Safety of Radioactive Waste Management. Pakistan reported that it had signed and ratified the Conventions on Early Notification of a Nuclear Accident and on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

There was continued progress in eastern Europe on a growing network of bilateral intergovernmental agreements on early notification of nuclear accidents, and on exchange of information and co-operation in the fields of nuclear safety and radiological protection. Developments in 1996 included the signing of an agreement between Poland and Slovakia, and draft agreements between Belarus and Ukraine and between Belarus and the Russian Federation.

## STRUCTURAL AND ORGANIZATIONAL DEVELOPMENTS

Some Member States described structural or organizational changes to operators and/or regulators that were considered to be significant for safety:

- Belgoprocess, a subsidiary of the Belgian national waste management company, was restructured to concentrate on the processing, conditioning and storage of waste from specific producers;

- In Bulgaria, new departments of Nuclear Safety and Radiation Protection were established to enable more efficient functioning of the Inspectorate for Safe Use of Atomic Energy;

- The Pakistan Nuclear Regulatory Board was established as a step towards achieving greater functional independence for the regulatory authorities. The functions of the Board include the approval of regulations, codes of practice and safety guides;

- A new Department was created in the Slovakian Nuclear Regulatory Authority with responsibility for safety analysis and technical support. An independent company, VYZ, has also been established for radioactive waste management and decommissioning;

- To take account of the restructuring and partial privatization of the UK nuclear operators, new licences were issued. This process raised interesting licensing issues where existing sites were divided between two different operators.

## OPERATION - SAFETY REVIEWS AND UPGRADES

Safety reviews and upgrades were being carried out at nuclear facilities in several countries:

- The steam generators at Doel 4 in Belgium were replaced. The materials testing reactor BR2 at Mol was undergoing extensive upgrading of control and safety systems, and was due to resume operation in 1997;

- At Kozloduy in Bulgaria, the improvement programme for units 1–4 (WWER-440 reactors) continued and is nearing completion, and a modernization programme for units 5 and 6 (WWER-1000 reactors) was developed on the basis of the experts report from an IAEA Safety Review Mission;

- The safety analysis report for the IAN-R1 reactor in Colombia was updated with assistance from the IAEA;

- Plans to conduct long term trials operating the TVO plants at 105% reactor power were approved by the Finnish Centre for Radiation and Nuclear Safety following trial operation and plant modifications. Also in Finland, a radiation embrittled weld close to the reactor core at Loviisa 1 was annealed at 475–500°C for 100 hours, allowing regulatory approval for operation of the reactor pressure vessel to be extended to 2004;

- The seismic hazard from the Paks power plant in Hungary was assessed, and plans of the necessary upgrading are under way;

- The probabilistic safety assessment of the Laguna Verde power plant in Mexico was revised by the utility following discussions with regulators, and major maintenance was carried out on the low pressure turbine discs;

- A safety review of the two nuclear power plants in the Netherlands led to the decision to close one station, Dodewaard, and to backfit extra safety measures at the other, Borssele.

- In Slovakia, safety upgrades were made on the operating WWER reactors at Bohunice and on the new WWER reactors at Mochovce. Short term upgrades on Bohunice were carried out during 1996, with the longer term measures due to be completed by 1999;

- Safety upgrades to the Krško power plant in Slovenia, including steam generator replacement, are planned in order to allow its continued operation;

- Replacement of the steam generators and the high and low pressure turbine sections, along with other upgrades, were carried out at the PWRs at Almaraz and Ascó in Spain. At Garoña BWR, a detailed inspection of the reactor vessel internals and the upper supports of the 20 jet pumps was performed during the refuelling shutdown;

- The oldest BWR in Sweden, Oskarshamn Unit 1, resumed operation following a major renovation programme;

- A long term safety review by the nuclear inspectorate of all of the UK's first generation of gas cooled reactors was completed. Ten of the eleven plants reviewed were granted permission to continue operation; the operators of the eleventh — Trawsfynydd — decided to close down the plant rather than complete the review.

**REGULATION**

New or revised safety regulations and guides, on a range of subjects, were reported to have been published in several countries, notably in China, Finland, Spain and Turkey. In addition, Colombia, the Czech Republic, Malaysia, Spain and Pakistan reported that they are in the process of producing new or updated regulations. An international peer review of Swedish regulatory supervision of the nuclear industry concluded that "The SKI and SSI are providing ample assurance of the confirmation and further development of safety and radiation protection in Swedish nuclear power production and waste management through their regulatory activities." The peer review commission also suggested changes that might further enhance the effectiveness of the regulators within available resources.

Other regulatory developments in the nuclear field included:

- The Müllheim-Kärlich PWR in Germany remained out of operation, following a decision by the Higher Administrative Court of the Rhineland Palatinate to revoke one of its licences on the basis that the earthquake risk had not been sufficiently evaluated. In January 1997 the Federal Administrative Court granted the plant operators a final appeal against the lower court's decision;

- The Spanish nuclear regulator CSN requested a detailed review of the design of safety systems on the PWR at Trillo, following the discovery during routine maintenance of inconsistencies;

- 'Special supervision' of the Barsebäck BWR in Sweden — a programme of special safety inspections introduced by the nuclear regulator SKI in 1994 — continued, as did a thorough review of the design and safety bases for all Swedish reactors;

- The operators of the Wylfa power station in the UK were prosecuted and fined heavily, following an incident in July 1993 when part of a fuel grab fell into the top of a fuel channel. The operators were criticized for not shutting down the reactor until several hours later;

- The US Nuclear Regulatory Commission launched a review of identified deficiencies in the operations of some licensees, where the operators have not fully adhered to the plant licence conditions. Specific examples were cited from inspections at Millstone Units 1, 2 and 3, and Haddam Neck.

Safety related progress outside the nuclear power industry included, in Colombia, a programme of registration for installations using radioactive materials, and development of new protocols for radiodiagnosis and radiotherapy, new Codes of Practice in Malaysia for non-destructive testing, mineral processing and the oil and gas industry, and restructuring of the licensing system in Pakistan for medical, agricultural and industrial users of radioactive materials.

## RADIATION EXPOSURE

Several Member States reported lower than expected worker exposure from maintenance and upgrade operations in nuclear facilities, as a result of improved planning of work. Sweden deviated slightly from this general trend in 1996, in that modernization work led to the highest occupational collective dose since 1993, although the trend in individual worker doses was downwards. India officially adopted the 20 mSv/a dose limit for workers recommended by international organizations.

Hungary and Ireland described surveys of public exposure from natural sources, especially indoor radon, allowing the identification of areas of high natural exposure. In Hungary, a survey of population exposure from photofluorography was due for completion in 1996. India reported that preliminary results from epidemiological studies on the population around nuclear power plants at Tarapur, Rajasthan and Kakrapar gave no indication of any radiation induced health effects. National radiation monitoring networks were established in Hungary and Tunisia.

## WASTE MANAGEMENT AND DECOMMISSIONING SAFETY

Existing waste storage and disposal facilities continued to operate without significant radiological incident, although shipments of high level waste (HLW) to the Gorleben storage facility in Germany attracted incidents of another kind, namely large scale antinuclear demonstrations. Meanwhile, work continued in several countries to investigate potential new disposal facilities for radioactive waste, particularly HLW:

- In Belgium, a site selection methodology to find a location for near surface disposal of low level (LLW) and short lived waste was completed, and will be submitted to a scientific consultative committee. The construction of an extension to the underground laboratory at Mol investigating the potential for HLW disposal in clay is due to begin shortly, and successful tests were completed on the canisters for HLW transport;

- China is revising its regulations and standards for radioactive waste management and the siting of disposal facilities;

- Work continued on the investigation of the Gorleben salt dome in Germany to determine its suitability for HLW and spent fuel disposal, whilst the licensing of the Konrad repository for non-heat-generating waste is expected in 1997;

- The first phase of a survey to identify suitable LLW and ILW disposal sites in Hungary was due to be completed by the end of 1996. This will determine which site(s) are to be investigated in greater detail;

- The Swedish regulator SKI recommended that the KBS-3 study on spent fuel disposal should be comprehensively updated and submitted for international peer review before starting exploratory drilling at potential sites.

In Belarus, the characterization and licensing of 69 'Chernobyl repositories' — the near surface facilities used for the disposal of waste generated in the post-Chernobyl cleanup operation — was completed. Work on an IAEA technical co-operation project on rehabilitation of the EKORES waste disposal facility was also started. In Colombia, irradiated fuel was removed from the core of the IAN-R1 reactor and shipped to the USA, and measures to develop a system for the control of remaining radioactive wastes were begun. Germany amended its guidelines on the verification of licensees' effluent monitoring, and issued new decommissioning guidelines summarizing pertinent regulatory requirements and good practice. The Philippines produced a range of procedures for the safe management of waste. A review by the UK's Nuclear Installations Inspectorate concluded that current storage arrangements for HLW in liquid form at the Sellafield site were acceptably safe, but that the waste should be vitrified as soon as practicable.

# NUCLEAR SAFETY REVIEW 1997

## PART III

## TOPICAL SAFETY ISSUES*

### 1. NUCLEAR SAFETY

### OPERATIONAL SAFETY EXPERIENCE

From the nuclear safety point of view, the continuing competitive economic environment was characterized by - inter alia - the restructuring of nuclear power-related organizations for the purpose of reducing costs, reductions in the resources being made available for safety upgrading programmes, and the inability of some countries to provide financial support for independent international safety assessments. Nuclear safety does not appear to have been affected so far, but the IAEA must continue adapting its safety services so as to ensure that the current positive trends in nuclear safety are not reversed.

Evaluations of operating events and results of IAEA safety missions have continued to reveal operational safety problems such as a lack of resources for the upgrading of normal and emergency procedures, variability in the quality of event analysis, and the failure of some managers and operators to identify and report deficiencies. Also, reviews have in some instances indicated poor industrial safety practices at nuclear sites and inadequate training programmes.

Over the past two years, however, plants hosting a follow-up mission 12 to 18 months after an OSART mission have demonstrated a high degree of compliance with the OSART recommendations, taking prompt action to introduce the improvements called for.

Studies of the underlying causes of recent incidents reported to the IAEA's Incident Reporting System (IRS) have resulted in a recommendation that plant operators pay more attention to events occurring under low-power and shutdown conditions.

Human error continues to be an important factor in nuclear power plant performance, and further work is being done to improve the reporting and the analysis of safety-related events where human error has played a role.

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* The issues touched upon in here are dealt with in greater detail in the IAEA Yearbook 1997.

## APPLICATION OF PROBABILISTIC SAFETY ASSESSMENT IN NUCLEAR SAFETY REGULATORY REGIMES

Probabilistic safety assessment (PSA) is considered a valuable tool for the evaluation of nuclear power plant safety and is being used in the plant licensing process and in regulatory decision-making generally as a complement to deterministic analyses. Regulatory bodies such as the US Nuclear Regulatory Commission have been making extensive use of results and insights from PSA, in combination with the traditional deterministic approach, when taking licensing decisions.

In Hungary, PSA applications were initiated in the early 1980s. A Level 1 PSA of Paks NPP Unit 3 was carried out in 1994, mainly in order to identify weaknesses in the original design and to set safety upgrading priorities.

In the Republic of Korea, the nuclear regulatory authority is adopting the integral safety assessment approach, which combines the deterministic and the PSA approach. In order to strengthen defence-in-depth, insights from probabilistic studies will have to be taken into account in the design of future nuclear power plants.

In the Slovak Republic, the nuclear safety authority considers PSA to be an essential tool for evaluating and improving the safety of nuclear power plants. However, it does not take decisions based solely on PSA results; a combination of deterministic and probabilistic methods is employed.

In the United Kingdom, the use of PSA has made it easier to carry out cost-benefit analyses. Nonetheless, the country's Nuclear Installations Inspectorate still requires deterministic/engineering judgements to be a fundamental part of the nuclear safety decision-making process.

## 2. RADIATION SAFETY

### PROTECTION OF PATIENTS AND THE SAFETY OF RADIATION SOURCES IN MEDICAL APPLICATIONS

Medical radiation exposures account for up to 20% of the annual per capita radiation exposure in industrialized countries - much more than the percentage due to industrial activities including nuclear power generation. They are the result mainly of diagnostic X-ray applications, with smaller contributions from nuclear medicine and radiotherapy.

In the medical applications of ionizing radiation, it is important that the doses be justified, in that the benefit to the individual or to society outweighs the radiation detriment, and optimized for the diagnostic or therapeutic purpose in mind, the exposure being enough for the desired information or therapeutic effect to be obtained - but no more. Lower doses are not always better, even in diagnosis; on the contrary, they may result in a need for repeat procedures, leading to unnecessarily high doses in total. In therapy, the dose should be precisely what is required - no higher and no lower.

In radiotherapy, where very large radiation doses have to be delivered precisely, good practices - and especially good quality assurance procedures - are important for the avoidance of accidents involving the misdelivery of doses. An IAEA report on lessons learned from accidents in radiotherapy which is about to be published should prove useful in this connection.

## A DECADE OF EMERGENCY PLANNING DEVELOPMENT

The differences in response to the Chernobyl accident in various countries underscored the need for a simple, internationally agreed set of consistent intervention levels; it also underscored the desirability of such a set of intervention levels as a means of increasing public confidence in the authorities dealing with the aftermath of an accident. In the event of transboundary releases, countries with no nuclear facilities of their own stand to benefit from the existence of consistent intervention levels even if they have not drawn up any detailed emergency response plans.

Accordingly, in 1994 the IAEA published a Safety Guide entitled "Intervention Criteria in a Nuclear or Radiation Emergency" (Safety Series No. 109), which represents an international consensus on principles for intervention and numerical values for generic intervention levels. These principles and values were incorporated as intervention guidance in the Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.

This guidance indicates some of the planning that must done in advance of an emergency, as it is now widely recognized that early in an accident there is insufficient time and information for determining the best protective action, so that detailed plans must be drawn up in advance. Also, it is widely recognized that socio-psychological effects can be very important in the longer term and that clear, authoritative advice based on careful advance planning can help greatly to alleviate the anxieties of affected people.

## 3. WASTE SAFETY

### CRITERIA FOR GUIDING THE REMEDIATION OF CONTAMINATED AREAS

The remediation of areas affected by residues from past nuclear activities has become an important issue in many countries, and the IAEA has been requested to provide assistance and advice in relation to residual radioactivity situations - for example, those at the nuclear test sites near Semipalatinsk (former USSR), at Bikini Atoll (United States) and at Mururoa and Fangataufa Atolls (France). The IAEA has carried out radiological assessments, but until recently no international guidance on radiological criteria for aiding remediation has been available. Also, guidance is required on cleaning up land and buildings as part of the decommissioning of old nuclear facilities and of areas affected by poor working practices in the past.

International working groups studying the subject in the context of the guidance provided by the International Commission on Radiological Protection and found in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources have made progress in developing a consistent and practical approach to the establishment of radiological criteria applicable to the different residual radioactivity situations, and an IAEA-sponsored working group will publish its preliminary guidance - for discussion - in the near future.

# NUCLEAR, RADIATION AND WASTE SAFETY IN MEMBER STATES

Information on significant achievements, developments and issues related to nuclear, radiation and waste safety, such as the enactment or revision of relevant laws and regulations, was requested from Member States in November 1996. The information provided by individual Member States is presented below.

## BELARUS

In the Republic of Belarus the following draft laws are in preparation:

— Law on the use of atomic energy and radiation protection;
— Law on radiation protection of the population.

A draft agreement is being prepared between the Government of the Republic of Belarus and the Government of Ukraine, entitled "Early notification of nuclear accidents and co-operation in the area of radiation protection".

A draft agreement is being prepared between the Government of the Republic of Belarus and the Government of the Russian Federation, entitled "Early notification of a nuclear accident, and the exchange of information relating to nuclear facilities and co-operation in the area of nuclear safety and radiation protection".

Work has been completed on the reconstruction and licensing of 69 facilities for the disposal of radionculide contaminated waste generated from the cleanup operation in the period immediately following the accident at the Chernobyl nuclear power plant. The radionuclide content, total activity and volume of the disposed waste have been determined.

Work has started on the implementation of the IAEA technical co-operation project "Rehabilitation of the EKORES Radioactive Waste Disposal Facility".

## BELGIUM

*Radioactive Waste Management - Main events*

*Transport*: The national radioactive waste management organization ONDRAF/NIRAS participated in the drafting of proposals from Belgium to modify the IAEA regulations (edition 1996) for the transport of radioactive substances.

*Processing and conditions of radioactive waste*: The new facility for the processing and conditioning of solid low level radioactive waste, which was officially inaugurated on 6 May 1994, was operated without any major problem and treated low level radioactive waste (compaction, incineration) according to the programme. In 1995, 70 t of combustible solid

and 15 t of combustible liquid waste were incinerated, 760 $m^3$ of non-combustible waste were compacted, and 570 $m^3$ of treated waste were embedded in cement in 400 litre drums.

Besides the normal processing and conditioning activities, studies have been launched in support of projects for the treatment of radium bearing waste and for the treatment of waste from the so-called HRA/Solarium[2] areas which form part of the nuclear liabilities of the Mol-Dessel nuclear site.

*Interim storage of conditioned radioactive waste*: The building for the interim storage of vitrified high level waste resulting from reprocessing by Cogéma in La Hague (France) of irradiated nuclear fuel from the Belgian nuclear power plants — which ONDRAF/NIRAS has constructed on the site of its subsidiary company Belgoprocess in Dessel and which cost some BEF 2025 billion — was made ready for industrial operation. Tests with the transport canister that will be used for the transport of the vitrified high level waste containers from La Hague to the site of Belgoprocess, proved to be positive and conclusive.

The first repatriation shipments will probably take place in 1997. As far as the transshipment port is concerned, two options remain open: the freight railway station of Mol, or the railway infrastructure located on the nearby military quarters in Geel.

*Disposal of conditioned radioactive waste*

*Near surface disposal of low level and short lived radioactive waste*: Studies related to the geological, radiological and environmental assessment and the selection criteria of the 98 identified potential zones for a near surface repository resulted in the preparation of a report in which these criteria are summarized and a selection methodology is presented. Before being presented to the competent authorities, the report will be submitted for evaluation to a consultative scientific committee and subsequently to the Board of Directors of ONDRAF/NIRAS.

Other studies conducted in this field relate to the assessment of the risk of infiltration of rainwater into the repository, the release of radionuclides from the repository, the transfer of $O_2$ and $H_2$ through the repository walls, the critical analysis of the intrusion scenarios, the behaviour of $^{14}C$ in the biosphere, the effects of gas production in the repository, and a selective drainage concept.

Finally, a study has been launched to assess the safety aspects and the costs of the various alternative options as far as the final management of low level radioactive waste is concerned.

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[2]HRA: High level radioactive waste;
Solarium: area where medium level waste was stored in the open air.

*Geological disposal of vitrified* high level waste in clay: Since the start of the PRACLAY programme (preliminary demonstration test for clay disposal) and the creation to that end of an economic interest grouping — the ESV PRACLAY, which ONDRAF/NIRAS and the national nuclear research centre CEN-SCK concluded on 21 June 1995 for a period of 15 years — enormous progress has been made in the field of research on geological disposal in the so-called Boom clay formation. The building licences for the construction of a second access shaft to the underground laboratory under the nuclear site of CEN-SCK in Mol, for a connecting gallery with the existing HADES galleries and of the so-called PRACLAY gallery were obtained 21 May 1996. Consequently, the necessary calls for tenders were published; in the meantime the tenders have been submitted and analysed. The area where the extension of the Hades underground laboratory will be built has already been deforested and prepared for construction works.

Studies related to the clay's macro-permeability, the preliminary simulation of the effects of glacial periods and the optimal composition of the filling material of the disposal galleries were finalized.

In addition, new studies have been launched dealing with the compatibility of cellulose containing waste with the Boom clay, the safety aspects of the disposal of irradiated fuel, the interaction of $UO_2$ and the Boom clay in the case of irradiated fuel disposal, and the solubility of critical radionuclides in the Boom clay.

Finally, a call for tenders was published for the realization of a seismic reconnaissance campaign the aim of which is to characterize more precisely the geometrical and stratigraphical composition of the Boom clay and other formations under the nuclear site of Mol-Dessel. The campaign has been prepared for execution in 1997; all communication and information aspects and contacts with the local authorities and public concerned have been dealt with in a very satisfying and positive way.

*Decommissioning of nuclear plants*: ONDRAF/NIRAS has continued its efforts in the field of the dismantling of nuclear plants, such as the former EUROCHEMIC pilot reprocessing plant in Dessel and the BR3 research reactor of CEN-SCK in Mol.

The first project is being carried out by Belgoprocess within the scope of a long term programme up to the year 2018. The second project is being carried out by CEN-SCK, under the co-ordination of ONDRAF/NIRAS. Both projects have made significant progress, although they are still far from being completed.

In addition, ONDRAF/NIRAS was charged by the Belgian legislator with the elaboration of national decommissioning plans for all nuclear reactors in the country (nuclear power plants not included) and has started together with the nuclear operators the necessary preliminary activities in this field.

*Restructuring of Belgoprocess*: The contract which ONDRAF/NIRAS concluded in 1978 with the German partner FzK (formerly KfK), for the vitrification of highly active concentrates from the WAK reprocessing plant of Karlsruhe in the PAMELA vitrification plant of Belgoprocess, was suspended by the German party in view of a probable final cancellation by June 1996. Consequently, the Board of Directors of Belgoprocess decided to reorganize the company in order to be able to cope with the decreasing activities over the next few years. The number of functions existing in the company is therefore being reduced significantly. The aim of this reorganization is to guarantee a system in which Belgoprocess commits itself to process, condition and store temporarily the radioactive waste for which the producers call upon its services, on the one hand, and in which the radioactive waste producers commit themselves to reserve a certain capacity of the services of Belgoprocess for the processing, conditioning and interim storage of the waste they produce on the other hand. By letter of 16 September 1996, the German partner FzK notified its final decision to cancel the contract and to build its own vitrification plant in Karlsruhe.

*Cassiopee*: The economic interest grouping CASSIOPEE, created in 1992 to assist east European countries in their waste management and nuclear power plant dismantling problems, developed various `terms of reference' for the management of radioactive waste in the Russian, Ukraine, Kazakhstan and Bulgaria. These terms of references were approved by the Commission of the European Union and can be put into execution.

*Nuclear power plants operation in 1996*

A major event was the replacement of the steam generators in Doel 4, which went smoothly with a total dose to the workers much less than foreseen, owing to very detailed organization of the work and the use of additional shielding.

In July a large leak occurred in a steam generator tube at Tihange 3, due to a loose object. Plugging the damaged tube, and neighbouring tubes to ensure a safety zone of two tubes in good condition, resulted in the preventive plugging of about 60 tubes.

In October an explosion took place in a circuit breaker at Tihange 1, when a circulating pump was started up. The plant went back to operation 10 days later, after repair and exhaustive safety analysis.

Problems connected with slowing down of control rods occurred during their insertion in the core after scram in the plants with a 14 foot core (Doel 4 and Tihange 3). For that reason Tihange 3 began its refuelling outage in December 1996, three months in advance of the earlier planned date. The loading pattern has been adapted so that control rods are adjacent to fresh or one-cycle-old fuel assemblies.

The construction of a large spent fuel pool at Tihange is progressing well; the pool should begin operation in 1997.

*Other nuclear installations*

The BR2 reactor, a material testing reactor which began operation in 1962 at the Mol Research Centre, was stopped in mid-1995 because its beryllium matrix had reached its maximum allowed fluence. The outage extended over the whole of 1996, with as main maintenance tasks the replacement of obsolete control and protection systems and the improvement of the reliability of many circuits, including the airtightness of the sub pile room, the reactor building and the containment penetrations. A number of studies were also performed, for example a seismic evaluation and a PSA.

## BULGARIA

*Measures for enhancement of NPP safety*

A contribution of a great importance to nuclear safety in Bulgaria was the improvement of the structure of the Committee on the Use of Atomic Energy for Peaceful Purposes (CUAEPP) in November 1996. Departments of Nuclear Safety and Radiation Protection were established in order to enable more efficient functioning of the Inspectorate for the Safe Use of Atomic Energy.

Enhancements to the safe operation of the NPP Kozloduy units have been implemented under CUAEPP direct supervision.

*Safety of WWER-440/230 units*: A programme for improvement of the reliability and safe operation of NPP Kozloduy units 1–4 has been carried out since 1991. Its main aims are as follows:

— Achievement of a safety level close to the originally designed level through restoration of equipment, structures and systems.
— Increasing the unit design safety level through improvements in the following fields: management and housekeeping; quality assurance; equipment requalification; personnel training and qualification; radiation protection; and emergency planning.
— Improvement of the main safety functions status by scientific research and implementation of modifications.

Specific programmes have been developed for achieving these targets. Implementation of these specific programmes was scheduled to be performed in three stages during three outages planned for maintenance and refuelling of the relevant unit.

The first and second stages have been finished for all four units as well as the third stage for unit No. 3. The third stage for units Nos 1, 2 and 4 is expected to be completed in the outage during 1997.

*Safety of WWER-1000 units*: At the request of the Committee on Use of the Atomic Energy for Peaceful Purposes, an IAEA Safety Review Mission visited the Kozloduy NPP units Nos 5 and 6 in June 1995. A report was issued by the IAEA. The Programme itself had been developed by the Kozloduy NPP Branch of the National Electricity Company JS together with Energoproject JS and Risk Engineering Co. Ltd. According to the reviewed programme the scope of safety upgrading measures can be divided into five groups as follows:

- Measures related to safety functions with the highest priority as follows: controlling the power in normal operation, transient and accident conditions; cooling the fuel; confining the radioactive materials.

- Measures requiring additional studies and analyses to be carried out on the following subjects: risk of common cause failure; accident analyses; system analyses.

- Measures required to solve maintenance problems, equipment failures and failures due to poor quality of specific components in the following: electrical and instrumentation & control systems; primary and secondary circuit.

- Measures required to improve significant operating and maintenance conditions as follows: management; maintenance; training; emergency planning; spent fuel and waste management.

- Development of decommissioning programme for units Nos 5 and 6.

A bid has been announced for implementation of this safety upgrading programme. The competitors have to finance implementation of the proposed measures using their own resources, and will subsequently be reimbursed by the Bulgarian utility. The results of the procedure were due to be announced in December 1996.

## CHINA

*Regulatory practices*

— The National Nuclear Safety Administration (NNSA) issued the Construction Permit to Qinshan NPP Phase 2 (2 × 600 MW PWR) 1 June 1996
— NNSA issued the Operation Licence to Unit 1 and Unit 2 of Daya Bay NPP, 29 August 1996
— NNSA issued the Construction Permit to Daqing 200 MW nuclear heating reactor 11 December 1996
— NNSA issued the Instrument of Ratification for the Safety Design of Transportation Vessel of the Nuclear Fuel Assembly, May 1996

Safety guides promulgated in 1996:

- HAF0202(1) Fire Protection in NPPs
- HAF0207(1) Emergency Power System at NPPs
- HAF0215(1) Seismic Analysis and Testing of NPPs
- HAF0301(1) Staffing of NPPs and the Recruitment, Training and Authorization of Operating Personnel
- HAF1001(1) Format and Content of Safety Analysis Report for Research Reactors
- HAF1005 Utilization and Modification of Research Reactors

*Waste management*:

- Revision and perfection of regulations, standards and guides associated with radioactive waste management, a preliminary system has been formed.
- Substantial progress achieved in siting and construction for the low and intermediate level waste (L/ILW) disposal sites.
  - Northeast China L/ILW Disposal Site
    In 1996 stress was put on engineering construction and preparedness for the site: preparation of operating and administrative regulations, QA programme, computer aided administrative procedures; environmental impact report before operation; technical training for operating personnel; etc.
  - Zhejiang L/ILW Disposal Site in East China
    Based on the plan of East China nuclear power development, the siting programme for Zhejiang L/ILW Disposal Site was prepared in 1996, two options — rock-cave disposal and near surface disposal — being suggested.
  - In order to match the requirements of operating L/ILW disposal sites, Provincial Management Rules of L/ILW Disposal were prepared in 1996.

## COLOMBIA

*Nuclear, radiation and waste safety at INEA*

*Achievements - nuclear and radiation safety*: The Regulatory and Licensing Office of the Colombian nuclear regulator INEA, with technical assistance from the IAEA, drafted a Nuclear Energy Law which has been submitted to the Office of INEA's Director General with a view to its being presented to the Ministry of Mines and Energy for approval. The draft is currently being examined by the Legal Office of the Ministry of Mines and Energy.

The following regulations were drafted by the Regulatory and Licensing Office:

- Regulations for the licensing of nuclear and radioactive installations;
- Regulations for the licensing of personnel; and
- Regulations for the licensing of the importation and transport of radioactive materials.

*Waste*: Irradiated and fresh nuclear fuel of high enrichment (90% and 93% respectively) was shipped to the USA, so that Colombia no longer has any radioactive waste from the fuel burnup which has taken place since 20 January 1965, the date on which the IAN-R1 reactor went critical.

An area within INEA's premises was adapted for receiving, characterizing and temporarily storing non-conditioned sealed sources which are no longer being used.

With the help of IAEA experts, INEA sources no longer being used were characterized with a view to their being conditioned in 1997.

*Developments* - nuclear and radiation safety: Personnel of INEA, the IAEA and General Atomics updated the Safety Analysis Report on the IAN-R1 reactor.

*Significant topics - nuclear and radiation safety - nuclear reactor*: Work was completed on the construction of an enclosure and a cooling pond for the temporary storage of irradiated fuel and radioactive structural elements and components from the IAN-R1 reactor.

Personnel of the Reactor Group, observed by the Radiation Protection Officer and other members of INEA's Radiation Protection and Nuclear Safety Division, dismantled the core of the IAN-R1 reactor, and the highly enriched fuel and the control rods were transferred from the reactor pool to the cooling pond.

Finally, the irradiated fuel was transferred from the cooling pond to the transport container for shipment to the Savannah River facility in the USA as mentioned above.

Zoning and other physical security measures were carried out at the reactor facility.

Some of these improvements can be seen in Figures 1–4.

*Radiation protection and nuclear safety division*: The following activities took place within the framework of a project entitled "Radiation Protection Implementation":

*Teaching*: Seven radiation protection courses were held for about 140 persons from the medical field and from industry.

A basic course on the inspection of radioactive installations was held for the personnel of `health secretariats', the bodies responsible for inspecting such installations in Colombia.

*Programmes*: A programme was launched for the registering and control of installations working with radioactive materials (installations which handle such materials and organizations which import them).

*Research*: Work was completed on the following:

— Preparation and characterization of lithium fluoride dosimeters;
— Drafting and application of a quality control protocol for radiodiagnostics;
— Analysis of protocols for the absolute dosimetry of photon and electron beams used in radiotherapy;
— Effects of ionizing radiation at the cellular level.

*Publications*: The lecture notes of a basic course on radiation protection ("Memorias de las Conferencias sobre el Curso Básico de Protección Radiológica") were published.

*Projects*: Together with the Colombian social security system (the Social Security Institute — ISS), a risk evaluation project was carried out covering the companies and other bodies belonging to the ISS which handle radioactive materials.

*Services*: The following services continued to be provided: calibration of equipment used in radiation monitoring and radiotherapy; personal dosimetry (film and thermoluminescence); radiation protection consultation; monitoring and inspections at radioactive installations.

*Waste*: A start was made towards collecting information on sources which are currently not being used, the aim being to decide on mechanisms for the management of such waste.

A start was made towards the training of personnel working in those areas of medicine which generate radioactive waste, the aim being to ensure the safe management of the waste.

A project for the management of sealed sources no longer in use and of nuclear waste was proposed to the National Planning Office. The project, to be implemented during the period 1997 – 2000, has been approved and resources to the amount of $280 000 have been allotted to it for 1997.

In addition, a contract has been signed for soil studies, architectural design work and structural calculations with a view to the construction of premises for the temporary storage of sealed sources no longer in use and of radioactive waste.

*Problems*:

— Staff limitations due to restructuring of INEA's staffing arrangements;
— The reduction of the State's economic resources due to the economic circumstances which the country is experiencing.

## CZECH REPUBLIC

In the Czech Republic a new Law on Peaceful Utilization of Nuclear Energy and Ionizing Radiation (the Atomic Energy Act) was approved by the Parliament. The Act consists of the following sections:

*Section 1 — Introductory Stipulations*

The section defines the scope of the Act, terms and definitions and powers of the State Office for Nuclear Safety.

*Section 2 — General Conditions of Activities Related to Nuclear Energy Utilization Radiation, Exposure, and Exposure Reduction*

This part contains general principles of nuclear energy and radiation source utilization, such as exclusively peaceful purposes. Nuclear safety and ALARA principles are explicitly given the highest priority.

*Section 3 — Conditions of Nuclear Energy and Ionizing Radiation Utilization*

This section provides detailed specifications under which different licences can be issued. It also specifies the responsibilities of licensees for nuclear safety and radiation protection, including their responsibility for emergency preparedness.

*Section 4 — Radioactive Waste Management*

In this part the State guarantees, under conditions defined in this Law, safe disposal of all radioactive wastes, including monitoring and supervision of repositories after their closure. The law authorizes the Ministry of Industry and Trade to establish a Radioactive Waste Repositories Agency and gives rules for its management and financing.

*Section 5 — Civil Liability for Nuclear Damage*

This section presents national legislation reflecting all obligations resulting from the Convention on Civil Liability for Nuclear Damage.

*Section 6 — State Supervision and Enforcement*

This part defines the powers of regulatory inspectors and means of enforcement applicable by the State Office for Nuclear Safety.

Sections 4 and 5 have been in force since 26 February 1997. The remaining parts of the law will come into force on 1 July 1997.

The Law authorizes the State Office for Nuclear Safety to issue 16 additional implementing regulations covering all specific areas related to utilization of nuclear power and ionizing radiation. Those regulation are in preparation.

The new nuclear legislation package will be consistent with internationally adopted principles of nuclear safety and radiation protection.

## EGYPT

Within the Atomic Energy Authority, the National Centre for Nuclear Safety and Radiation Control continued its work on the review and assessment of safety in the following activities:

— Review and assessment of the existing Research Reactor (ET-RR-1)
— Gamma irradiator
— Accelerator
— Second research reactor ET-RR-2 (under construction)
— Review and assessment of use, handling, transport and storage of radioactive materials and the disposal of radioactive wastes, and
— Preparation of regulation, rules, principles and criteria related to nuclear safety.

## FINLAND

*Trial operation of TVO I at 105 % reactor power*

In connection with the power upgrading of the TVO plant units, trial operation at 105% reactor power was started at TVO-1 after the 1996 annual maintenance outage. It is intended to continue the trial operation of TVO-1 at this reactor power until the 1997 annual maintenance outage. According to a decision by the Ministry of Trade and Industry, trial operation at a reactor power exceeding rated power can be conducted by virtue of the current operating licence, provided that an approval from the Finnish Centre for Radiation and Nuclear Safety (STUK) is obtained.

Based on TVO's clarifications and the Centre's own safety assessment, STUK noted that trial operation of TVO-1 at 105% power is safe. In its statement, The Advisory Committee on Nuclear Safety was in agreement with the Centre's opinion about the acceptability of the long-term trial operation of TVO I plant unit at 105% reactor power.

The most important modifications implemented in the 1996 annual maintenance outage as regards the TVO-1 power upgrading were the increasing of the reactor overpressure protection capacity, the renewal of the turbine control system and the increasing of the shutdown reactor residual heat removal. In addition to these, the plant unit main generator was replaced and extensive turbine modifications were carried out. The electric drive of one primary circulation pump was altered to slow down the pump's stopping in the event of loss of electrical power. Other pumps will be correspondingly modified later provided that no problems are observed in the operation of the modified pump during the one-year trial operation period.

Prior to the commencement of the long term trial operation at 105% reactor power, tests were carried out at TVO-1 in connection with the plant's startup to ensure the performance and acceptability of systems modified during the outage in both normal operation and during certain transients. The most important transient test was a load reduction test during with the plant's connection to the national grid was cut off while operating at 105% reactor power. In the load reduction test, TVO-1 successfully switched on to house-load operation during which the plant unit is supplied the necessary electrical power by its own main generator. After the test, the plant unit was reconnected to with the national grid.

STUK oversaw the trial operation, i.e. by checking the trial operation programmes and the plant modifications made, by witnessing tests at the plant site and by reviewing the test reports. Based on this control, the Centre gave its approval for the commencement of long term trial operation at 105% power.

*Annealing of reactor pressure vessel at Finland's Loviisa plant*

Neutron irradiation causes changes in the microstructure of steel and the changes raise the transition temperature indicating the brittle behaviour of steel. At lower temperatures the steel's ability for plastic deformation deteriorates and it becomes brittle. If, at such a temperature, the structure is subjected to high stresses and if there is a sufficiently large crack at the point concerned, the crack will grow quickly and the structure will break. High stresses at a low temperature can arise for example during emergency cooling. Reactor pressure vessels are regularly inspected to detect any flaws.

Steel's impurities increase the susceptibility to changes in the transition temperature which is induced by neutron irradiation. There are impurities particularly in the welded seam in the core region of the Loviisa 1 reactor pressure vessel.

The materials test specimen irradiated inside the Loviisa- reactor pressure vessel in 1980 showed that embrittlement took place considerably faster than the design values presented by the plant supplier indicate. Several modifications have been made at both plant units to slow down the embrittlement of steel and to limit potential overcooling transients.

The ductile properties of steel can be restored close to the original by annealing for several days at a temperature of 475°C. This method has already been applied to more than ten foreign reactor pressure vessels of the WWER-440 type. The station operator Imatran (IVO) has been carrying out annealing related studies for several years.

The Finnish Centre for Radiation and Nuclear Safety in 1993 decided to allow the extended operation of the Loviisa 1 reactor pressure vessel until the 1996 refuelling outage. The decision required measures to reduce the brittle risk of the pressure vessel. Imatran Voima Oy made a decision to anneal the reactor pressure vessel and started the work required for the execution of the annealing and for the new operating licence.

In older foreign reactor pressure vessels of the WWER-440 type, samples have been taken before and after annealing thus ensuring the restoration of fracture toughness. The inner surface of the Loviisa-1 pressure vessel is covered by a 9 mm thick welded stainless steel cladding which prevents a sample being taken from the weld. Therefore, the restoration of fracture toughness must be shown in some other way. That is why a sufficient number of systematic studies were required to indicate the restoration of material properties, the rate of re-embrittlement and also the reliable measurement of the temperature of the welded seam during annealing to keep the temperature within the range determined by materials studies. It was also required that the annealing does not harm the reactor pressure vessel or the structures surrounding it. STUK reviewed and approved the annealing plans.

In the 1996 refuelling outage, an embrittlement welded seam closest to the reactor core was annealed to 475–500°C for one hundred hours. The annealing was carried out by a joint enterprise formed by Skoda and Bohunice nuclear power plant and the annealing went according to the approved programme and without deviations. STUK witnessed the execution of the annealing.

STUK approved, according to the application of IVO, the operation of the Loviisa reactor pressure vessel until the 2004 refuelling outage. In support of the application, IVO submitted the pressure vessel's safety analysis which has been reviewed by the Centre. The transition temperature for the year 2004 has been very conservatively calculated and IVO will re-evaluate it before the year 2004 utilizing, for example, the results obtained from the samples manufactured of the tailored weld material placed inside the pressure vessel in 1996 to irradiate them. After three years, the samples will be annealed and placed in the core again for re-irradiation.

*Regulations: YVL Guides*

STUK, the Finnish Centre for Radiation and Nuclear Safety, is the authority regulating the use of nuclear energy. Its duties include preparation of detailed regulations pertaining to the safety of nuclear facilities. The regulations are set forth in YVL Guides issued by the Centre. Besides presenting safety requirements for nuclear facilities, the YVL Guides also describe the regulatory procedures used by the Centre. The YVL Guides are rules any individual licence holder or other organization concerned must comply with unless the STUK is presented with some other acceptable method or solution by which the safety level set forth in the YVL Guides is achieved.

These Guides deal with the design and operation of nuclear power plants in general, the systems and pressure vessels of nuclear power plants, structural engineering relating to nuclear power plants, other structures and components plus radiation protection and nuclear waste management. Some of these Guides have been translated into English.

The revision and updating of the Guides has been enhanced in recent years. During 1996, 12 YVL Guides dealing with the following subject areas have been revised: general guides, nuclear power plant systems, pressure vessels, radiation protection and nuclear waste management. Guides concerned with the safety principles to be complied with in the design of nuclear power plants, transient and accident analyses, primary and secondary circuit pressure control, assurance of safety functions and PSA were given particular priority in the revision process.

## GERMANY

The general energy policy of the German federal Government keeps to its position to guarantee a secure, cost effective and ecologically beneficial energy supply. That requires that the peaceful use of nuclear energy will contribute to the German energy supply in the future.

Despite conflicting views on the country's future energy policy and particularly on the role of nuclear energy, the German federal Government has initiated `Energy Consensus' talks among the leading political parties. No common position on the further use of nuclear energy has been reached so far. The negotiations were abandoned in June 1995 but have been resumed in 1997.

Since 1988 the Mülheim-Kärlich NPP (PWR, 1302 MW(e)) is out of operation due to continuing court procedures. In its decision of 21 November 1995 the competent Higher Administrative Court of the Rhineland-Palatinate state has revoked one of the licences of the NPP stating that the earthquake risk has not been sufficiently evaluated. The plant owner announced that they would use all possible legal means to bring the NPP back on line. On 9 January 1997 the Federal Administrative Court gave the plant owners a final appeal against a lower court decision of November 1995 not to allow the plant to return to service.

In 1996 German NPPs continued safe operation. A total of 135 events according to the National Reporting Criteria were reported. Out of these, 129 events were rated as INES level 0, and six events were rated as INES level 1.

The safe operation of German NPPs is also reflected by the fact that the radioactive emissions resulting from NPP operation remained far below the permitted limits.

On 20 January 1997 the German federal Government deposited its instrument of ratification at the IAEA in Vienna for the Convention on Nuclear Safety. Germany will take part in the preparatory meetings of the contracting parties at the IAEA in Vienna.

To support licensing and regulatory supervision of decommissioning nuclear facilities, a `Decommissioning Guideline' was issued summarizing all pertinent regulatory requirements and good practice. This was published in `Bundesanzeiger' 211 A, 12 November 1996.

The guideline on `Verification of the Licensee's Monitoring of Radioactive Effluents from Nuclear Power Plants' was amended on 5 February 1996.

Since German reunification, the Morsleben repository in the former German Democratic Republic has the status of a federal repository for short lived and low level radioactive waste. Since January 1994, a total volume of 5688 $m^3$ of radwaste had been disposed of by the end of 1995, and a total of 11 162 $m^3$ by the end of 1996.

The former iron mine Konrad is designated for the final disposal of radwaste with negligible heat generation. The licensing procedure is in an advanced state. A positive decision of the competent licensing authority of the state of Lower Saxony is expected in 1997.

At the Gorleben site a salt dome is being investigated for its suitability for disposal of all kinds of radwaste, particularly high level waste and spent fuel. For this purpose, two shafts have been sunk to a depth of 840 m, where galleries for the exploration will be excavated. On 21 October 1996, the shafts were connected at a depth of 840 m.

At the Gorleben site there is also an interim storage facility for high level radwaste as spent fuel or vitrified high level waste from reprocessing abroad. Up to now, eight casks have been transported by three shipments to the interim storage facility, always accompanied by a series of violent anti-nuclear demonstrations.

For the Technical University at Garching near Munich a new research reactor FRM II will be erected to serve as a high neutron flux source. The core is designed in a compact configuration and will be loaded with highly enriched uranium fuel. On 9 April 1996 the state of Bavaria granted the first partial construction licence for the FRM II covering the construction of the reactor building. In May 1997 the granting of the second partial construction licence is expected.

In 1996, Germany has continued its assistance to improve the nuclear safety in the New Independent States and central and eastern European countries both on bilateral and multilateral (G7) level.

Germany pursued its assistance by bilateral support pilot projects and has participated in complementary multilateral assistance programmes.

The German bilateral assistance concentrated on pilot projects for Rovno and Balakovo NPPs, providing urgently required hardware to enhance the operational safety of these NPPs of WWER-1000 type. Furthermore, German assistance to the development and strengthening of regulatory authorities has been continued.

## HUNGARY

*Nuclear, radiation and waste safety*

Four nuclear power units in operation with 460 MW(e) capacity each at Paks NPP, a research reactor with 10 MW(e) capacity at KFKI-Atomic Energy Research Institute and a training reactor with 100 kW capacity at the Technical University of Budapest, Institute for Nuclear Techniques are under the supervision of the Nuclear Safety Inspectorate of the Hungarian Atomic Energy Authority (HAEA-NSI).

Units 1, 3 and 4 of Paks NPP have been refueled as planned. Unit 2 was on its extended surveillance programme carried out every four years. During the maintenance work loose parts were found unexpectedly in the primary circuit. This prolonged the outage time of the unit. Events of INES level 1 or higher did not occur.

The new Atomic Energy Act has been endorsed by the Government and the Parliament is currently discussing it. In connection with the new act, all governmental and ministerial orders as well as regulatory documents have to be renewed. The new recommendations of ICRP Publication 60 and the International Basic Safety Standards issued in 1996 are being taken into account.

In 1996 Hungary became a member of the OECD and joined the Nuclear Energy Agency and its Data Bank. A National Committee for co-ordinating and managing Hungarian participation in the work of NEA has been established and nominations for the Steering and the Standing Committees have been decided. A decision on Hungarian participation in working groups will be made soon.

As an important milestone in the seismic upgrading programme of the Paks NPP the seismic hazard of the site has been determined. With the assistance of the PHARE programme of the European Union an assessment has been made of the seismic character of the site. It has been stated that as the safe shutdown earthquake, a 0.25g horizontal acceleration should be taken into account. An IAEA mission reviewed the study (it has followed the work since 1993) and gave a positive indication of its acceptability. The HAEA-NSI approved this evaluation and gave permission for further steps of upgrading. The technological concept for shutdown and long term cooling of all units has been submitted to HAEA-NSI for approval. Requirements have been formulated and based on these criteria permission can be expected in the near future. The completion of the programme is scheduled for the end of 2001.

The 12-year periodic safety review is under way for Paks units 1 and 2. The deadline for submission of the complete document is November 1996; a decision on the renewal of the operational licence was due to be made by the end of 1996.

The installation of a dry storage facility for spent fuel elements is approaching the final stage. Permission for commissioning and operation will be issued by the Hungarian Atomic Energy Commission (HAEC). For enhancing the capability of NSI in emergency preparedness, installation works for a Centre for Emergency Response, Training and Analysis (CERTA) have been started. Hardware and software specifications have been made and international assistance has been requested from both the IAEA and PHARE sources as well as from bilateral governmental contacts.

A survey of indoor radiation levels has been carried out in Hungary, including the measurement of radon concentrations and dose rates from external sources in one thousand dwellings. The annual individual effective dose to the Hungarian population based on the weighted means of values received within this programme is 1.3 mSv from radon inhalation and 0.4 mSv from external sources for an assumed indoor occupancy of 5000 hours per annum.

A national survey of population exposure originating from photofluorography examinations will be concluded in 1996.

The Information Centre of the Nationwide Environmental Radiation Monitoring System (NERMS) has been established. Tests of connections and data transmissions between this centre and the data centres of the monitoring networks belonging to different ministries and authorities are in progress.

The installation and adoption of the Real-time On-line Decision Support System (RODOS) for response to accidents have been started with the assistance of the CEC.

A National Radwaste Management Project was launched in 1993 to solve the problem of the handling and disposal of LLW/ILW from the Paks NPP. On the basis of the results of a geological survey and a the preliminary safety analyses and with account taken of public acceptance, the Board of the National Project selected three potential geological objects, where site exploratory surveys were carried out — in a granite formation for a geological repository and in loess formations for a nearsurface repository. The first phase of the National Project will be closed by the end of 1996. It will then be decided which of the prospective sites should be explored in detail. If further work on this selected site does not meet the expectations, the investigation will be continued on other sites.

The HAEC decided to start a three-year research programme aimed at the preparation for HLW disposal. The programme includes investigations in a siltstone formation in the Mecsek Hill, a country-wide geological survey based on existing data, and the elaboration of a long term strategy for further activities.

## INDIA

During the year the performance of the Indian Nuclear Power Plants in the areas of nuclear, radiation and industrial safety was entirely satisfactory. In addition, special efforts were instituted to upgrade safety in nuclear power plants.

At all the nuclear power plants, the lower limit of 20 mSv/a recommended by ICRP 60 has been adopted. India is only the third country to do so.

Epidemiological studies have been completed at the Tarapur, Rajasthan and Kakrapar Atomic Power Stations. A preliminary review indicates that there are no radiation induced health effects.

## IRELAND

In November 1996, the Radiological Protection Institute of Ireland published the first results of its national radon survey. The primary objective of the survey is to determine, in detail, the geographical distribution of radon levels in dwellings in Ireland. The survey is based on the 10 km grid squares of the Irish National Grid System. Radon measurements are carried out in selected dwellings and the data are used to predict the percentage of dwellings in each grid square with radon concentrations above the reference level of 200 $Bq/m^3$. Grid squares where the predicted percentage of dwellings with radon concentrations above 200 $Bq/m^3$ is 10% or greater are designated `high radon areas'.

The average radon concentrations for the houses measured in counties Cavan, Dublin, Louth, Monaghan and Wicklow ranged from 69 to 138 $Bq/m^3$, with individual values as high as 1000 $Bq/m^3$. Approximately half the area of County Wicklow and smaller areas in counties Louth, Cavan, Monaghan and Dublin are designated as high radon areas.

In these areas, the Institute encourages householders to have radon measurements made in their homes in order to identify the individual dwellings with elevated indoor radon levels. Where high radon levels are found, householders are encouraged to take the necessary action to reduce the risks to themselves and their families. The Institute also advises that all new dwellings being built in high radon areas include some radon preventive measure.

The survey, which is being carried out on a phased basis, is currently under way in a further 16 counties and is due for completion in 1998. A map entitled "Radon in Irish Dwellings" showing the results from this report and from previous surveys carried out by the Institute has also been published. Data for further counties will be published as they become available.

## MALAYSIA

*Nuclear radiation and waste safety issues and development 1997*

Malaysia considered and made an initiative towards the adoption of the recommendations of ICRP 60 and the new International Basic Safety Standards.

The current Radiation Protection (Basic Safety Standards) Regulations 1988 were required to be amended and a new draft of the Regulations was prepared through technical assistance from the IAEA. However, the implementation is expected to encounter some difficulties, especially in the classification of working areas and perhaps the shielding of exposure rooms.

A code of practice for non-destructive testing (NDT) workers was drafted and implemented, in which the dose limit was revised from the 29 mSv based on ICRP 26, to 18 mSv, where the ALARA concept is taken as a vital principle.

Through the IAEA's technical assistance, codes of practice for Amang (Mineral) Processing and the Oil and Gas Industry (industries associated with technologically enhanced naturally occurring radioactivity) were drafted.

Significant achievements: The first phase of the proposed decommissioning of a radiocative mineral processing plant — prepapring and evaluating the highly technical documents involved — has been completed. The decommissioning of the plant and the site are scheduled to start in early 1997 and expected to be completed within two years.

## MEXICO

*Report on the nuclear situation in Mexico during 1996*

Both units of the Laguna Verde Nuclear Power Plant underwent refueling and major maintenance activities. The major maintenance activity consisted of changing the low pressure turbine disks, as a result of the appearance of cracking on the disks. It was determined that the cracking was caused by premature stress corrosion, and because of the

remaining life of both units (U-1 started commercial operation in 1990 and U-2 in 1995), it was decided to make this major change instead of minor or temporary repairs. The maintenance took three months for each unit. Figures 5 and 6 show the development of this work.

During the year two different projects were started by the regulatory body, with the aim of upgrading the Technical Specifications of the Laguna Verde NPP. The results of the projects will include the so-called `Electronic Tech Specs' and an improved document.

The PSA of Laguna Verde NPP Level 1 was revised by the utility on the basis of comments and discussions with the regulatory body. With this updated version it was possible to initiate in 1995 the PSA Level 2, which was also delivered to the regulatory body during 1996. In this context, the regulatory body started a project to use the results of these PSA studies to develop a risk based monitor to check the maintenance programmes and the allowed outage times.

Several studies were presented by the utility to the regulatory body in the context of seeking approval to operate in different situations unforeseen in the Safety Analysis Report, for example: (1) Operation with a single recirculation loop imposed by the malfunction of the discharge valve (upstream of the recirculation pump); (2) Operation with one of the main steam lines closed owing to locking of one of eight isolation valves. Both studies were supported by analysis performed by the designer of the nuclear steam supplier system, General Electric (GE), and the engineering department of the utility. The regulatory body gave the permit to operate under the circumstances described on the basis of a probabilistic (PSA Level 1 study) and deterministic (GE's studies) approach.

As part of the strategies to develop in-house capabilities in the area of PSA and consequence analysis, the nuclear regulatory body (National Commission for Nuclear Safety and Safeguards, CNSNS) is developing a PSA for the Laguna Verde Nuclear Power Plant (LVNPP), independently of the utility but using the same point of origin of the PSA Level 1 results. The MACCS code is currently the main tool for this purpose. CNSNS has participated in the two meetings of the International MACCS Users Group presenting specific results. The final objective is to reach an integrated risk assessment, combining the PSA level 1 and 2 results. On the other hand CNSNS is also exploring the possibilities of using the COSYMA code in the specific conditions of the LVNPP.

The safety culture philosophy was encouraged by all managerial levels of Mexican nuclear installations. A seminar was conducted with the support of the IAEA, and as a result of this meeting the Laguna Verde NPP initiated a special programme to increase the safety culture in plant personnel.

As part of the programme to develop the technical capability to fabricate nuclear fuel in the country, a project to produce four nuclear fuel assemblies, starting from uranium dioxide powder, was finished. The four assemblies were delivered to the Laguna Verde site, and will be part of the core during the second cycle of Laguna Verde U-2. This fabrication was performed by the National Nuclear Research Institute.

## THE NETHERLANDS

An integral safety re-evaluation, including an environmental impact assessment and PSAs, has led to backfitting measures for both nuclear power plants in the Netherlands at a total cost of $250 million. Implementation of these measures in the nuclear power plant Borssele will be completed by the end of 1997. Implementation in the nuclear power plant in Dodewaard, however, will not be completed as the owner, the electricity company SEP, decided in late 1996 to shut this plant down by the end of March 1997. Development of a policy for decommissioning and appropriate licensing are currently in progress.

## PAKISTAN

The Pakistan Atomic Energy Commission (PAEC) has signed and ratified the Conventions on Early Notification of a Nuclear Accient and Assistance in the Case of a Nuclear Accident or Radiological Emergency. Pakistan has also signed the Convention on Nuclear Safety; ratification is pending legislative and executive approval. Although Pakistan has not yet ratified the Convention, steps have already started for the implementation of obligations under this Convention, such as providing more functional independence to the regulatory body, the Pakistan Nuclear Regulatory Board (PNRB). The function of PNRB includes approval of the regulations, codes of practice and guides and overseeing and reviewing the performance of the Directorate of Nuclear Safety and Radiation Protection (DNSRP). The DNSRP remains responsible for execution of the statutory requirements of the Pakistan Nuclear Safety and Radiation Protection Ordinance, 1984. The creation of PNRB is a transitional phase towards achieving an independent status for the regulatory organization in Pakistan.

In 1996, DNSRP restructured the licensing schedule for the use of radiation apparatus and radioactive material in medicine, agriculture and industry. In the radiation protection area, the 1982 Basic Safety Standards is used as the controlling document. However, adoption of the 1996 Basic Safety Standards is under way.

## THE PHILIPPINES

The Philippine Nuclear Research Institute (PNRI) conducted nuclear regulatory information conferences during 1996 aimed at improving safety related management in the use of radioactive sources in the Philippines. Six conferences were conducted on the use of radioactive sources in industrial gauges, teletherapy and brachytherapy, radiography, radiopharmaceuticals, research and education, and by commercial licensees.

Some safety related issues were identified at the conclusion of the conferences. Being addressed are: the need to establish criteria for accrediting professional societies; the need to revise some safety related PNRI Bulletins; the development of training modules on the Code of PNRI Regulations; frequency of leak testing of sealed sources; and enforcement actions on expired licences.

To ensure the safe management of radioactive wastes, the following procedures on processing, treatment and conditioning were developed by the Institute:

- Coding system for unconditioned wastes/spent sealed sources
- Coding system for conditioned wastes
- General procedures in waste management
- Treatment and conditioning of aqueous liquid wastes
- Treatment and conditioning of organic liquid wastes containing $^{14}C$ and $^{3}H$
- Processing of combustible solid wastes
- Processing and conditioning of radium sources
- Conditioning of spent sealed sources (other than $^{226}Ra$)
- Radioactive waste monitoring procedures.

## POLAND

*Significant achievements in the field of nuclear and radiation safety*

- On 17 September 1996 the Foreign Ministers of Slovakia and Poland signed a bilateral intergovernmental agreement on early notification of a nuclear accident, on exchange of information and co-operation in the field of nuclear safety and radiation protection (the agreement was approved by the Polish Government on 28 November 1996). This was the fifth document of the kind signed recently with neighbours of Poland (others include Ukraine, Lithuania, Belarus and the Russian Federation), strengthening significantly the nuclear safety system of the region.
- In May 1996, the Polish Government approved the Strategic Governmental Programme "Management of Radioactive Waste", creating the legal basis for budgetary spendings for R&D and organizational tasks to be performed in the period 1997–1999 in the field. The programme should provide solutions to be used during the construction of new radioactive waste repositories in Poland.
- From 24th to 26th of June 1996 in Miedzeszyn near Warsaw the Polish National Atomic Energy Agency organized a regional seminar on three subjects:
  - early warning radiation monitoring systems,
  - national systems for radiation emergency situations,
  - national systems preventing illicit trafficking of nuclear materials and radiation sources.

The meeting, partly supported by the IAEA, involved representatives of 15 countries of the region, presenting national solutions to the problems. Papers were distributed among the participants and final conclusions were transmitted to the competent national authorities.

## SLOVAKIA

The year 1996 in Slovakia could be characterized by the extraordinary scope and importance of activities related to improvements in nuclear safety.

After several years of preparation and selection from several solutions, in April the supply contract and in May credit agreements were signed for completion of the first two units of Mochovce NPP with the goal of putting into operation the first power plant with a WWER reactor satisfying current safety standards.

In compliance with the decision of the national regulatory authority, focused on the achievement of an acceptable safety level for Bohunice NPP V-1, in May the REKON consortium signed a supply contract for the safety upgrading of NPP V-1 with the completion by 1999. The Nuclear Regulatory Authority (UJD SR) completed an assessment of the safety report for NPP V-2 prepared by the operator after 10 years of operation and, by a regulatory resolution, obligatory tasks were determined for safety improvement of this NPP.

After several years of interruption, the original intergovernmental agreement of 1956 was renewed, which enabled transport of four damaged fuel elements from the decommissioned Bohumice NPP A-1 to the Russian Federation. By establishment of the independent VYZ company, focused on the decommissioning of NPPs and management of radioactive waste, better conditions were created for effective work progress in the decommissioning of NPP A-1. UJD SR has been further strengthened to fulfil all its tasks in supervising nuclear safety.

More information on individual activities and events are provided below:

*Operation of nuclear power plant in Bohunice.* Operation of four WWER 440 units (2 × V 230 and 2 × V 213) in Jaslovské Bohunice, which are the most important components of the Slovak power sector, remained stable and reliable. Safety indicators were satisfactory, e.g. fault rate, low collective dose and radioactive effluents, prevention of operating events which would endanger the plant and the environment by radiation. International commitments of Slovakia in relation to the IAEA safeguards system against misuse of nuclear materials were also fully met.

*Safety upgrading of V-1 and V-2 units of Bohunice NPP.* For Bohunice V-1 NPP a two stage programme of safety upgrading has been developed. The first stage, i.e. short term safety upgrading measures, has been completed and implementation of the second stage is under way with task completion scheduled for 1999 according to the step-wise safety upgrading plan.

Periodical assessment of the safety of the V2 NPP has been also performed. On the basis of its review, UJD SR required the plant operator to develop a programme for short term upgrading. At the same time, the operator was required to introduce an `Essential Safety Improvement' programme, related mainly to seismic resistance and instrumentation and control system upgrading.

*Construction of Mochovce NPP.* A total of 87 safety upgrading measures have been developed to ensure the current safety standard of the first two units. The safety upgrading measures are categorized according to safety issues ranked into three categories established by the IAEA. The detailed design solutions are under elaboration at present.

Currently, pre-operational work on technological equipment is continuing with the aim of startup of Unit 1 in 1998. The work is being performed in line with the approved time schedule.

*Interim spent fuel storage.* An interim spent fuel storage facility is in operation at the Bohunice site. The storage capacity of this water pool facility is 5040 fuel assemblies (FAs). At the end of 1996, 4656 FAs were stored, including 636 FAs from the Czech Dukovany NPP. Transport of Dukovany spent fuel began in 1996 and will be completed at the end of 1997. To extend the capacity of existing spent fuel storage an essential reconstruction is planned, consisting of:

— the use of compact baskets with a higher capacity of 48 FAs (at present, 30 FAs); subcriticality will be maintained by borated steel in the basket material
— higher number of baskets in pools by better utilization of the pool volume.

In the course of reconstruction, additional technical improvements will be implemented.

*Radioactive waste management*. The operational radioactive waste from four WWER-440 units as well as from the A1 NPP are stored in special tanks and stores at the NPP sites. Since 1995 a bitumenization plant with an output of 120 L/h, and 200-litre steel drums as a final product has been in operation for conditioning of liquid waste. Another plant with the same capacity will be commissioned in 1997. A vitrification plant is in operation for conditioning of the special intermediate level liquid waste chrompik, the original coolant of spent fuel in A- NPP.

A near surface disposal facility for low and intermediate level waste has been built at the Mochovce site with a capacity of 36 000 $m^3$. At present some modifications are being implemented as required by the regulatory authority during the licensing process.

Special high integrity concrete containers have been accepted for disposal of all conditioned waste. A waste conditioning centre for segregation, fragmentation, incineration, supercompaction, cementation and grouting of all preconditioned waste in accepted containers is under construction.

*Decommissioning.* NPP A-1 (HWGCR) is under decommissioning after its final shutdown in 1977. After contamination of the reactor hall in 1991, decontamination took place. After this was finished in 1996, activities were focused on the development of a new technology for transport of damaged spent fuel from a near-reactor pond to the Russian Federation.

*Nuclear legislation.* A new law on the Peaceful Uses of Nuclear Energy (Atomic Act) has been elaborated and submitted for approval to improve the existing nuclear legal system. The law fully reflects the country's obligations resulting from international agreements, mainly

the Convention on Civil Liability for Nuclear Damage and the Convention on Nuclear Safety. The law also improves the specification of responsibilities and further prescribes conditions for nuclear safety during the whole lifetime of nuclear facilities.

*Nuclear regulatory authority*. Besides fulfilling its essential function of State supervision over the safety of nuclear installations, UJD SR has performed a number of other significant tasks. A decisive condition for efficient work in 1996 was stabilizing and strengthening the number of highly qualified experts. Several emergency exercises organized by the Emergency Response Centre of UJD SR took place, including joint exercises with the Bohunice NPP and the Headquarters of the Slovak Army. Since October a separate department has been established at the Authority dealing with safety analysis and technical support. Intergovernmental agreements were signed with the Czech Republic, Canada and Poland. At the headquarters of the UJD SR, a regional IAEA co-ordinator office was opened for co-ordination of projects in the area of radioactive waste and radiation protection.

## SLOVENIA

In 1996 the Parliament adopted the so-called "Energy Strategy" in which the options of continuing with and without nuclear energy were considered, the main strategic aim being to provide conditions to give up the nuclear option. A decision to shut down the Krško NPP would need to be taken at least 10 years in advance. Until then, priority will be given to plant safety aspects, improvements and maintenance. In this respect, the most important investments are:

— Steam generator replacement and power uprating (for which an evaluation of international bids is taking place),
— Provision of a full scale plant specific simulator.

A referendum to shut down the Krško NPP did not take place since there were not enough signatories to support this initiative.

## SPAIN

*Report on operating safety of nuclear power plants*

During 1996, the nine nuclear power stations in Spain were in operation without any incident resulting in radiological impact to the public or the environment.

Significant upgrades and modifications took place in some plants. In Almaraz Unit 1(PWR), replacement of the three steam generators, the reactor vessel head, the turbine high and low pressure sections, and the control rods actuation mechanisms was carried out with very limited exposures as a result of adequate planning of the replacement programme. For early 1997 the replacement of steam generators for Unit 2 is scheduled, together with other major components.

In Ascó Unit 1 (PWR), the replacement of the steam generators and the high and low pressure turbine sections was carried out in 1996, also with very limited radiological impact on the workers.

For the Trillo NPP (PWR) the regulatory body (CSN) has asked for an exhaustive programme (1996–1997) to review the design of the safety systems since inconsistencies were found during maintenance operations. The review programme includes hardware, instrumentation and control, software and documentation.

A detailed inspection of the reactor vessel internals and the upper supports of the 20 jet pumps in Garoña NPP (BWR) was performed during the refuelling shutdown.

Only one event classified as level 1 on the INES scale was reported at an operating NPP in 1996. The event took place in the Ascó NPP where a design modification affected the full availability of the feedwater service to the safety systems.

*Main issues on radiological protection*: Dosimetric control of personnel of operating plants and contractors covered 9 213 persons in 1996. The average collective dose for 1996 was 0.898 Man·Sv per nuclear facility.

The Vandellós-1 NPP (gas-graphite) is continuing its decommissioning programme. A minor exposure incident, during the cleaning of the fuel water pool storage, with very limited effects, has been reported. Dosimetric control on a total 222 persons showed that 4 workers had been exposed to about 40% of the annual limit, 5 other workers had been exposed, but to less than 25% of the annual limit. The Vandellos-1 incident was also categorized on INES level 1.

Spain has accepted the engagement to host in 1997 an International Conference on the biological effects of low level radiation and its regulatory control.

*Main issues on waste management*: Spent fuel from Spanish NPPs will be temporarily stored at reactor sites. The safety authority CSN has issued a favourable position towards the dual-purpose container ENSA-DPT for irradiated fuel transport and storage.

Since the capacity of spent fuel pools in some Spanish NPPs is nearly full, the CSN is authorizing 'reracking' activities to increase the storage capacity of the pools and therefore delay the need for out-of-pool storage.

The waste storage facility for medium and low activity waste, operated by ENRESA at the El Cabril site continued its operation in 1996 without any safety or radiological incident.

*Legislation*:

- A process has been initiated for high activity wastes that involves the Spanish Senate in order to reach agreement between the political parties on the

legislative framework. The initiative, similar to that in other countries, will contribute to addressing high level waste storage problems.

- A study is being initiated to review the Decree 2869/1972 concerning regulations on nuclear and radioactivity installations.

- CSN issued two new safety guides: GS-1.9 on emergency exercises and GS-1.10 on periodic reviews of NPP operating safety. Several other guides have been revised and updated.

## SWEDEN

*Report on radiation protection*

Occupational exposures: The total occupational collective dose for the four nuclear power stations during 1996 is the highest since 1993. Then it was about 27 Man-Sv and in 1996 it will be of the order of 22 Man-Sv. The reason for this relatively high occupational collective dose is the more extensive work to modernize the facilities and also a more extensive testing programme.

Although the collective doses are increasing, the individual dose distribution shows a tendency to shift to lower dose levels.

No incidents causing radiation doses of interest, to individuals or groups of individuals, have been reported.

During 1996 the facilities continued their work with short term as well as long term dose reduction programmes. The main issue is to implement the following: "In order to achieve sustainable safety development at a nuclear installation, the radiation protection of the workers shall constitute an integral part of the development process and cannot be considered in isolation from it."

Radioactive waste: In addition to the expected operational waste generated at the power plants, a few larger components have been replaced during the year or are scheduled to be replaced in 1997.

*Current regulatory activities and safety issues*

The nuclear power option in Sweden: The Swedish Parliament decided in 1980, after the TMI accident in 1979, to phase out nuclear power in Sweden by the year 2010. The phasing out has so far not started. A decision in 1988 to shut down two reactors by 1995–1996 was revoked as the energy production alternatives had not yet been evaluated, bearing in mind environmental and welfare goals.

In the summer of 1994 an Energy Commission was appointed by the Government, charged with evaluating, in regard of the deregulation of the energy market, the current energy production policies and proposing measures to ensure efficient supply of energy in the future. In its report to the Government in December 1995, the Energy Commission presented its views on the issue of restructuring and developing the energy system of Sweden.

The Commission also noted the importance of maintaining a continuing high level of safety at the operating reactors and the extensive work that is needed in the field of disposal of spent nuclear fuel. The Commission says "the workload and resource requirements of SKI (Swedish Nuclear Power Inspectorate) and SSI (Swedish Radiation Protection Institute) may grow more than they already have in recent years. It is important that these authorities should have sufficient resources for their monitoring activities and for research, as well as for developing competence and for international exchange of experience. Society's supervision for nuclear safety and the State's overall responsibility for it must be preserved."

*Currently operating reactors and the licensing situation*: There are 12 licensed power reactors in Sweden, the Forsmark and Oskarshamn sites, each with three BWRs, the Barsebäck site with two BWRs and the Ringhals site with one BWR and three PWRs. All are currently operating.

The operating licences granted for nuclear power reactors commissioned after 1980 are valid until the end of 2010. The four oldest reactors have no time limits assigned to them (Barsebäck Unit 1, Oskarshamn Units 1 and 2, Ringhals Unit 1). Certain limitations have in addition been imposed by the Swedish Government in conjunction with permits granted during the recent years for power rating upgrades at several units. The permits to operate at the increased power level thus expired by the end of 1996 for three of the BWRs, a prolongation of two years have been granted by the Government in December 1994. In conjunction with the exchange of the steam generators at one of the PWRs in 1989 the Government decided to grant a licence for continued operation which was limited until the end of 1995; later extended to 1 July 1997. Applications for extended licences have been submitted by the utilities.

*Events of safety significance*: Occurrences and events reported during 1996 up to the present time include one event rated level 2 and five events related level 1 on the INES scale.

The level 2 event took place in Oskarshamn-2, which is a BWR. During the periodic testing on 13 November 1996 it was discovered that the motors to both emergency core cooling spray pumps were electrically disconnected. After recognition of the situation the operators immediately (within 11 minutes) acted and activated the system. Two weeks earlier prior to startup after refuelling, all sysems had been checked according to the Technical Specifications and found in order. Later, however, an additional test was performed, the containment leak test. Owing to the risk of activation of the emergency core cooling system in relation to this test the electrical disconnectors to the pumps were opened. The electrical disconnectors were left in the open position until the first periodic test of the emergency core cooling system, which took place one week after the reactor had been put into operation.

After notification, the SKI immediately sent a team of three inspectors to the plant to investigate the cause of the event. The report of the team revealed some shortcomings in regard to verification of safety, such as deficiencies in procedures to verify the operability of important safety systems affected by tests of other systems and lack of clarity in routines to report in writing deviations from normal procedures.

On the basis of this event, the SKI issued on 28 November 1996 a generic letter to all utilities requiring them to check and report to the SKI on the procedures and possible improvements in procedures as a consequence of the findings from the Oskarshamn 2 event and earlier events of a broadly similar type.

*Special supervision of Barsebäck plant*: During 1994 a number of circumstances caused the SKI to initiate special regulatory actions regarding the Barsebäck plant. These actions comprised special inspections and examinations of the safety work at the plant. The utility responded by developing an action programme to counteract the situation and to get rid of the deficiencies causing the problems. One reason for the problems was the large reorganization at the plant in 1994. This special supervision of the Barsebäck plant has continued throughout 1995 and 1996. The latest regulatory activity, a large team inspection, is presently being evaluated.

*Major review and reconstitution of the safety bases for the reactors*: The Barsebäck clogged strainer incident revealed a major deficiency in the basic (deterministic) safety analyses forming an important part of the design basis of the emergency cooling systems. This prompted major programmes at the utilities, under way since the beginning of 1993, for thorough review of all the design and safety bases as documented in the FSARs for all Swedish reactors. The programmes have been estimated to require more than 500 person years at the utilities, together with substantial efforts on the part of the BWR vendor, ABB Atom. The work under way should reach completion in 1998. It provides a substantial complement to the periodic safety review of each unit as performed in Sweden at 8–10 year intervals since the beginning of the 1980s. Corresponding work on PWRs is presently being organized and should reach completion by the year 2000.

The programmes, followed closely by SKI, should aim at reconstituted FSARs based on revised safety analyses and design bases as necessary, verification that there is consistency between the plants as built and operated and the FSARs, appraisal of the reconstituted FSARs in view of modern safety standards, and proposals for any measures to comply with them.

*Major overhaul and design update of the oldest BWR*: The oldest BWR, Oskarshamn Unit 1, started operation in 1972. It was shut down in September 1992, in the first instance owing to the so-called strainer problem but later owing also to cracking, detected mainly in non-annealed pipe bends in the primary system and in feed water piping inside the reactor vessel close to the pipe penetrations through the bottom part of the vessel. The reactor has been subject to a major renovation programme, called FENIX, aimed not only at restoring it to original status but also to considerable upgrading in regard of safety. The reactor resumed operation in December 1995.

The status of the reactor vessel has been successfully verified, including the bottom parts with control rod penetrations, which have previously not been accessible for testing. This required major dismantling and removal of all reactor vessel internals and chemical decontamination of the reactor vessel and parts of the primary system. The decontamination proved highly successful, allowing the personnel to work comfortably in the reactor vessel without time pressure and still with limited radiation exposure. In addition, safety provisions and safety systems were upgraded for improved compliance with modern safety standards. Thus, for example, all cabling in the containment was replaced and environmentally qualified according to recent standards, and the physical separation of the safety systems enhanced for improved safety with regard to flooding and fires.

The SKI decided on 18th December 1995 to grant permission to resume operation of the reactor until the 1996 refuelling and maintenance outage. The permission concerns operation under special supervision and can be extended up to the 1999 outage providing certain conditions specified by the SKI are fulfilled, including the implementation of a modernization programme in terms of measures of importance for safety. For the operation of the reactor between 1996 and 1998, SKI requires that additional tests and inspections are carried out, with regard to cracks in the core shroud head as well as in valve and pump housings in the reactor recirculation loops. Every year, the utility must also describe remaining measures of significance to safety in the modernization programme. This programme includes the replacement of the core shroud head, completion of the cable separation outside the containment, and modernization of steam isolation valve systems and the emergency core and residual heat removal systems and related power supply.

The project has raised a number of important issues relating to safety requirements to be set for nuclear reactors built to earlier standards and is followed closely by the SKI. Therefore, following the completion of the review of the Oskarshamn issue, the SKI issued a generic letter to all Swedish utilities requiring them to review, for their own reactors, the various safety issues that have emerged from the Oskarshamn renovation project and assess their safety significance for their reactors. The reports by the utilities are presently being reviewed by the SKI.

*Report on the safety status of Swedish nuclear power plants in the period 1995–1996*: The SKI and the SSI submit once a year, after the annual refuelling and maintenance outages, a report about the status of safety and radiation protection to the Government. The report for 1995–1996 was delivered in November 1996. The conclusions of the report include:

— The newer reactors of the modern design and the older reactors exhibit different safety profiles but do not differ significantly in regard to overall safety assessment. This reflects the benefits from the continuous efforts made over time to improve the safety of the operating reactors.
— The modernization of the reactors continues and significant efforts to improving the safety were observed. Considerable investments are being made by the utilities.
— Issues related to ageing need continuous attention, but the in-service inspection programmes appear to have the capability to detect degradation before major component failures occur.

- The development of improved inspection methods needs to continue, in particular the work towards qualification of the methods and personnel as regards in-service inspection.
- Few new fuel leakages have occurred. However, the issue of bent nuclear fuel needs attention and continued supervision.
- The experience from the Oskarshamn-1 renovation needs to be taken into consideration in safety work. The importance of the ongoing review and reconstitution of the safety bases for all reactors is being underlined.
- The importance of organizational factors to achieve high quality in safety is underlined. The utilities have put emphasis on developing further their organizational systems and processes. Modern quality systems are being applied. Also, the importance of advance and long term planning has been underlined. In this work to improve safety culture significant progress has thus been made — however, at a different pace at the different utilities.

Recognizing that the Swedish reactors were licensed on an individual safety case basis in the 1970s and early 1980s and in order to be able to give a proper regulatory response with regard to major modernization programmes planned by the Swedish nuclear utilities, SKI has started a project, R2000, aimed at defining common safety requirements for all Swedish reactors as a condition for operation in the first decade of the next millennium — or even longer, depending on the energy policy decisions.

*Final disposal of spent fuel*: On the basis of past experience with the site selection process for a final repository for spent fuel and high level waste, the Government is presently considering an amendment to the law on nuclear activities in order to clarify the responsibility of the industry implementor (SKB) with regard to the preparation of an environmental impact assessment (EIA) to be submitted as a part of a siting and licensing application and with regard to the consultations with local communities that have to take place during the preparation of such an EIA. The Government has also appointed a special co-ordinator to facilitate consultations and co-ordination between local communities, county administrations, central authorities, SKB and environmental organizations in the preparation of EIAs and licensing applications for the various installations required for encapsulation and final disposal of spent fuel and high level waste generated by the Swedish nuclear programme.

Every three years, according to legal requirements, SKI reviews the SKB research, development and implementation programme with regard to final disposal of spent fuel. The most recent review was completed in the early months of 1996. A major SKI recommendation is that the SKB should carry out a comprehensive and thoroughly updated performance assessment of the KBS-3 final disposal concept, and submit the results to an international peer review, before starting exploratory drilling of potential sites. The purpose is to ensure that the design and evaluation of borehole measurements can be based on such an updated performance assessment.

*The international peer review*: In 1994, the Government decided that an international review group should be appointed to review and assess the quality of the Swedish regulatory supervision of reactor safety and of the handling, storage and final disposal of nuclear waste.

The report was submitted to the Minister of the Environment on 10 May 1996. In general terms, the opinion of the Commission is that the regulatory work of the SKI and the SSI adequately serves its purpose, and the Commission concludes that "The SKI and SSI are providing ample assurance of the confirmation and further development of safety and radiation protection in Swedish nuclear power production and waste management through their regulatory activities." They also conclude that "Swedish regulatory activities are conducted in a satisfactory manner, compared with the practice in other countries with a similar approach to safety as that of Sweden."

The Commission also identified areas in which the SKI and SSI should consider changes in the manner in which the activities are carried out in order to increase their effectiveness within available resources. Such areas concern the promulgation of general regulations, the elaboration of more measurable objectives, the implementation of modern internal quality systems, etc. In addition to addressing the authorities, the Commission also directs some of its recommendations directly to the Government, particularly when it comes to matters such as stated objectives and the economic resources given to the authorities. The Commission notes that the authorities "have difficulties in coping with their present workload." Also, both authorities will, in the near future, meet an increasing demand on their regulatory activities as a result of external developments Considering also the fact that services from a national technical support organization are not available in Sweden, the Commission urges the Government to "consider in the current budgetary discussions the Commission's recommendations, giving special attention to the providing of outside technical support; and continue its dialogue with the SKI and SSI respectively, in order to ensure that allocated resources are consistent with stated objectives."

The review report has now been submitted for comment to the nuclear utilities, and a number of other authorities and interested parties. SKI will be required to report back to the Government by 1 July 1997 on actions taken as a result of the recommendations of the Commission. On its side, SKI has welcomed the report by the international peer review Commission and will use it as a vehicle to further enhance the quality and efficiency of the work of the organization. In fact, SKI has already started to develop a new internal quality system, called SKIQ, in accordance with modern industry criteria.

## TUNISIA

As far as radiation protection is concerned, the Directorate of the National Radiation Protection Centre has confirmed that it has not detected any overexposure to radiation of any person handling radioactive sources or radioisotopes either in the country's hospital centres or in its industrial facilities or agricultural research institutions.

Moreover, the study on the establishment of a national radiological network has been completed with a view to measuring the natural or artificial radioactivity at all points of the country's territory and thus detecting any future variation.

With regard to the transport and circulation of radioactive materials, a training programme for specialized Customs and Interior Ministry personnel is being prepared and will soon be discussed with the IAEA. The training of the staff responsible for this area will cover the tasks foreseen in the application of international conventions and common safety standards.

## TURKEY

In 1996 the Turkish Atomic Energy Authority has prepared two regulations (code and practice). These are:

— Regulation for the Establishment and Working Procedures of the Nuclear Safety Advisory Committee of the Turkish Atomic Energy Authority; and
— Regulation for the Accounting and Control of Nuclear Materials.

These regulations have been completed by the Atomic Energy Committee and sent to the Ministry for the final approval.

## UNITED KINGDOM

*Restructuring and privatization*

On 9 May 1995 the Government announced to Parliament its intention to restructure Britain's nuclear power industry and privatize the advanced gas-cooled reactor (AGR) stations and the Sizewell B PWR in the middle of 1996. The Nuclear Installations Inspectorate (NII) was tasked with managing the relicensing of the sites, ensuring that the entire process was transparent, rigorous and robust, while meeting the Government's target date for privatization. The Government acknowledged that the present standards of safety at nuclear power stations are adequate and these will be maintained via the present non-prescriptive licensing system that has been used successfully for more than 35 years.

In their proposals, licence applicants covered a range of topics including: management structure and arrangements; funding of liabilities; management of change arrangements; impact of change on safety and licence condition arrangements; and the preparation of inter-company contracts by which the new companies will share safety facilities and expertise on a contractual basis. The latter was particularly important with respect to specialist technical support teams and for the splitting of AGR or PWR and Magnox sites, which are now owned by separate companies. The licence applicants were also required to consult relevant public bodies as part of the relicensing process.

NII assessed the licensees' proposals and inspected selected aspects of their implementation. As part of the overall relicensing strategy, a series of individual site and corporate inspections were conducted to sample particular generic topics including: central emergency arrangements, incident reporting and operational experience feedback and technical support. Inspections were conducted at all the sites; some sites were also the subject of focused inspections into site specific issues such as the splitting of the site. Also of

importance was the assessment of the licence applicants' abilities to adequately discharge their responsibilities as licensees.

New nuclear site licences for 16 nuclear power station sites came into force at midnight on 31 March 1996. All the Magnox power stations (apart from two owned by British Nuclear Fuels) have been transferred to a public sector operator, Magnox Electric plc. The newer stations, comprising the AGR stations and the Sizewell B PWR station, are now owned by a new company, British Energy plc, through its two subsidiaries — Nuclear Electric Ltd (NEL) and Scottish Nuclear Ltd (SNL) — which will operate the stations. British Energy, together with its subsidiaries, was privatized in July 1996.

*THORP*

Inactive commissioning of the Thermal Oxide Reprocessing Plant (THORP) at Sellafield commenced in January 1992 and the first chemical separation of irradiated fuel into re-usable uranium and plutonium took place in January 1995. This has resulted in the successful recovery of uranium and plutonium, which could eventually be utilized in the manufacture of new fuel elements in the Sellafield Mixed Oxide Fuel Plant which is being constructed adjacent to THORP.

The THORP plant, which is operated by British Nuclear Fuels plc (BNFL), has been closely regulated by the Nuclear Installations Inspectorate (NII) on behalf of the Health and Safety Executive since design proposals were formally acknowledged by NII in February 1983. The plant is now completing a period of active commissioning using irradiated fuel of increasing burnup and decreasing cooling times. Once the commissioning is completed BNFL will apply for permission from NII to take the plant into routine operation.

*Sizewell B*

A major milestone for the UK nuclear industry was reached when the first UK civil PWR, Sizewell B, was taken critical for the first time on 31st January 1995. This had followed an intensive period of plant preparation and commissioning by the plant operators, Nuclear Electric, and a team inspection led by the NII Site Inspector in December 1994 to confirm Operational Readiness. A member of the US Nuclear Regulatory Commission experienced in PWR startup joined the team to observe the testing which followed initial criticality. Following this, power was raised progressively as commissioning proceeded on both reactor and turbine plant. The reactor reached its full power output for the first time in late June and completed its 100 hour 100% output proving run in July 1995. The final major tests of the commissioning programme were completed in the following weeks, culminating in a final set of tests which were witnessed by the NII. This included a reactor trip from 100% power and subsequently a natural circulation test. Consent for Routine Operation was given by the Inspectorate on 22 September 1995. Consent marked the acceptance by the inspectorate that the work involved in the design, construction and commissioning of the plant

has been satisfactorily completed. The station completed its first operational cycle in June 1996 following a continuous 270-day power run.

*Wylfa prosecution*

In September 1995, Nuclear Electric plc (NE) was fined £250 000 with costs of £138 000 following an incident in July 1993 at Wylfa Power Station. This was the largest fine ever imposed on a nuclear operator in the UK. The incident involved the failure of a grab which is used during on-load refuelling of the reactors. The grab came apart at a joint and the lower part fell about 12 m from a refuelling machine into the top of a fuel channel in the reactor core. The reactor operators did not shut down the reactor until several hours after the grab component was seen to be missing because the reactor was behaving normally and they believed that it was lodged above the reactor core. During that period the local reduction in coolant flow meant that the cladding of the fuel elements could have melted, but any damage would have been confined to one of the reactor's 6156 fuel channels, so there was no risk of major core damage.

At the trial the judge said that the lapses relating to the incident in 1993 were very serious indeed. However, he rejected any suggestion that the shutdown of the reactor was deferred for commercial reasons and he was sure that safety was in the forefront of the operators' minds although they were in error in failing to trip the reactor. Following the incident, NE modified the design of the grab and introduced revised operating instructions. NE also checked the designs of other refuelling components at all its power stations to ensure that similar failures could not occur.

*Long term safety reviews*

NII's report on the findings of its assessment of Nuclear Electric's (NE) Long Term Safety Review (LTSR) for the Wylfa power station was published in December 1995. The report confirms that the station can operate up to 2004, when it will be 33 years old. By then the licensee will be required to have undertaken a further periodic safety review (PSR) if it wishes to continue to operate the Wylfa reactors. In parallel with the LTSR, a number of significant safety issues have been examined as part of a generic programme across all Magnox stations. At Wylfa this has already led to the introduction of: improved fire detection and suppression systems; an Emergency Indication Centre; additional backup cooling systems; and improved reactor shutdown systems as well as additional plant inspections and further safety analysis.

The report marked the end of a series of reviews of LTSRs on all of the UK's Magnox stations. Ten of the eleven Magnox stations reviewed satisfied the NII's assessment criteria and were given approval to continue in operation until at least 30 years of age (longer in a few cases). Only for Trawsfynydd did the operator decide not to complete the LTSR and that station is now being decommissioned. The first of the UK's AGRs at Hinkley Point and Hunterston, are now approaching the age when a PSR is due.

*High level waste storage*

In 1995, NII issued a report setting out its views on the safety of the storage of high level liquid waste at BNFL's Sellafield site. The high level waste (HLW) arises from the reprocessing of spent nuclear fuel at Sellafield, and takes the form of a concentrated solution of various radioactive elements in nitric acid. One of its characteristics is that is generates heat and so the HLW is stored in a number of water cooled highly active storage tanks. NII concluded that storage of HLW in liquid form is not the most appropriate regime for the long term and supported the policy that the liquid should be vitrified as soon as practicable. Nevertheless, NII does not believe, on the basis of present evidence, that it is necessary to take special measures to accelerate the current rate of emptying of the tanks, and has concluded that the current storage arrangements are acceptably safe.

## UNITED STATES OF AMERICA

*Regarding adequacy and availability of design bases information*

In the mid to late 1980s, NRC safety system functional inspections (SSFIs) and safety systems outage modifications inspections (SSOMIs) identified concerns that design bases information was not being properly maintained and plant modifications were being made without the licensee having an understanding of the plant design bases. The NRC's findings heightened the nuclear industry's awareness of the need to improve the adequacy and availability of design documentation, and many licensees voluntarily initiated extensive efforts to improve the design bases information for their plants.

To provide more information to the industry on this topic and to provide an independent view of the design control issue, the staff conducted a survey of six utilities and one nuclear steam supply system vendor to determine the status of design control problems and the strengths and weaknesses of the sample utility programs. The results were published in February 1991 in NUREG-1397, "An Assessment of Design Control Practices and Design Reconstitution Programs in the Nuclear Industry". The survey observations were as follows:

— The need for a design documentation reconstitution programme was directly proportional to the age of the plant.
— The general intent of the programme should be to provide a central location for design bases information, with emphasis on the design intent (the "why" of the design).
— The design bases documents should be a top-level directory that defines the current plant configuration.
— Re-establishment of design bases without reconstitution of the supporting design documents, as necessary, may not provide a sufficient level of information for future modifications or current plant operation, or to quickly respond to operating events.
— Minor changes to the design should be tracked to support the conclusion that the changes in the aggregate do not affect the validity of existing calculations and the ability of a system to perform its design functions.

Some common weaknesses of licensee programmes identified during the survey included the following:

— Design reconstitution programmes had not identified in advance the documents that are necessary to demonstrate that a structure, a system, or a component will function properly.
— The process for regenerating missing design documentation was not always proceduralized so that it could be handled in a systematic manner.
– Validation of the content of specific output documentation was not always thoroughly carried out.

*Current problem*

Over the past several months, NRC's findings during inspections and reviews have identified broad programmatic weaknesses that have resulted in design and configuration deficiencies at some plants, which could impact the operability of required equipment, raise unreviewed safety questions, or indicate discrepancies between the plant's updated final safety analysis report (UFSAR) and the as-built or as-modified plant or plant operating procedures. These inspections and reviews have also highlighted numerous instances in which timely and complete implementation of corrective action for known degraded and non-conforming conditions and for past violations of NRC requirements has not been evident. Overall, the NRC staff has found that some licensees have failed to (1) appropriately maintain or adhere to plant design bases,[3] (2) appropriately maintain or adhere to the plant licensing basis,[4] (3) comply with the terms and conditions of licences and NRC regulations, and (4) assure that UFSARs[5] properly reflect the facilities. The attachment provides examples of some of the deficiencies recently identified by the staff. As a consequence of this new information, the NRC believes that the industry's voluntary efforts to improve and maintain design bases

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[3]As described in 10 CFR 50.2, design bases is defined as, "Design bases mean that information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design..." The design bases of a facility, as so defined, is a subset of the licensing basis and is contained in other documents, some of which are docketed and some of which are retained by the licensee.

[4] The licensing basis for a plant originally consists of that set of information upon which the Commission, in issuing an initial operating licence, based its comprehensive determination that the design, construction and proposed operation of the facility satisfied the Commission's requirements and provided reasonable assurance of adequate protection to public health and safety and common defence and security. The licensing basis evolves and is modified throughout a plant's licensing term as a result of the Commission's continuing regulatory activities, as well as the activities of the licensee.

[5]The FSAR is required to be included in, and is one portion of, an application for an operating licence (OL) for a production or utilization facility. 10 CFR 50.34(b) describes the information which must be included in an FSAR. The FSAR is the principal document upon which the Commission bases a decision to issue an OL and is, as such, part of the licensing basis of a facility. It is also a basic document used by NRC inspectors to determine whether the facility has been constructed and is operating within the license conditions.

information for their plants, consistent with NUMARC 90-12, the staff's comments on the industry guidelines, and the Commission policy statement, have not been effective in all cases.

The magnitude and scope of the problems that the NRC staff has identified raise concerns about the presence of similar design, configuration and operability problems and the effectiveness of quality assurance programmes at other plants. Of particular concern is whether licensee programmes to maintain configuration control at plants licensed to operate are sufficient to demonstrate that plant physical and functional characteristics are consistent with and are being maintained in accordance with their design bases. The extent of the licensees' failures to maintain control and to identify and correct the failures in a timely manner is of concern because of the potential impact on public health and safety should safety systems not respond to challenges from off-normal and accident conditions.

NRC's position has been, and continues to be, that it is the responsibility of individual licensees to know their licensing basis, to have appropriate documentation that defines their design bases, and to have procedures for performing the necessary assessments of plant or procedure changes required by NRC regulations.

The NRC has concluded that it requires information that can be used to verify licensees' compliance with the terms and conditions of their licence(s) and NRC regulations, and that the plant UFSAR(s) properly describe the facilities as well as to determine if other inspection activities or enforcement action should be taken. Therefore, licensees are required, pursuant to Section 182 (a) of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54 (f), to submit a response to this letter within 120 days of its receipt. Licensees' responses must be written and signed under oath or affirmation.

US utilities are being required to submit the following information for each licensed unit:

— Description of engineering design and configuration control processes, including those that implement 10 CFR 50.59, 10 CFR 50.71 (e), and Appendix B to 10 CFR part 50;
— Rationale for concluding that design bases requirements are translated into operating, maintenance and testing procedures;
— Rationale for concluding that system, structure and component configuration and performance are consistent with the design bases;
— Processes for identification of problems and implementation of corrective actions, including actions to determine the extent of problems, action to prevent recurrence, and reporting to NRC; and
— The overall effectiveness of current processes and programmes in concluding that the configuration of plant(s) is consistent with the design bases.

In reporting to items (a) through (e), the licensee is to indicate whether it has undertaken any design review or reconstitution programmes, and if not, a rationale for not implementing such a programme. If design review or reconstitution programmes have been completed or are being conducted, a description of the review programmes, including identification of the systems, structures and components (SSCs), and plant-level design

attributes (e.g. seismic, high energy line break, moderate energy line break) is to be provided. The description should include how the programme ensures the correctness and accessibility of the design bases information for each plant and should confirm that the design bases remain current. If the programme is being conducted but has not been completed, an implementation schedule for SSCs and plant level design attribute reviews, the expected completion date and method of SSC prioritization used for the review is to be provided.

*Background information on recently identified problems*

Over the past several months, design and engineering information has been obtained that indicates that design bases at certain plants have not been appropriately maintained or adhered to. Specific examples follow:

*Millstone Units 1, 2 and 3*: An NRC inspection team recently found examples in which design bases information and the Updated Final Safety Analysis Report (UFSAR) did not agree with the as-built plant, operational procedures, and maintenance practices. The team found inconsistencies that required analyses, procedure changes and design changes to resolve. For example, the Millstone Unit 3 operating procedures required isolation for the turbine-driven auxiliary feedwater pump during certain plant conditions, in conflict with technical specification requirements for operability. The team found that certain protective relays at Millstone Unit 3 were not set in accordance with the design bases information. This required re-analyses and resetting of certain relays. On the basis of the team's findings, the licensee initiated design changes to correct non–conforming conditions between the UFSAR and the as-built plant, including changes to the design of the Millstone Unit 2 reactor protection system to meet the design bases with respect to physical separation of redundant channels and changes to the design of the Millstone Unit 2 (post-loss-of-coolant accident (LOCA)) hydrogen monitors to meet the design bases for single failure vulnerabilities.

*Haddam Neck*: An NRC inspection team found examples in which the design bases information and the UFSAR did not agree with the as-built plant, operational procedures and maintenance practices. The team identified a number of deficiencies in engineering calculations and analyses that were relied upon to ensure the adequacy of the design of key safety systems. Deficiencies were identified in the calculations and analyses supporting the station batteries, emergency diesel generators, containment cooling system and other key safety systems. In some cases, the inspection findings were resolved by revising the calculations and analyses. In other cases, procedure and design changes were required to resolve the issues. For example, the team identified that the design bases calculations supporting the size of the station batteries were inconsistent with the design bases stated in the FSAR. Field measurements and design modifications were required to resolve this issue.

Other issues were identified by the NRC and the licensee following the issuance of this special team inspection report that led the licensee to enter a refueling outage earlier than originally scheduled. Discrepancies included inadequate configuration management of the containment sump design and as-built conditions; a lack of detailed analysis and technical

justification for the reliance on post-accident back pressure inside the containment to assure adequate net positive suction head for the residual heat removal pumps; inadequate inspection and verification of the sump as-built and material.